AMERICAN ENGINEER AND RAILROAD JOURNAL

NEW YORK [ETC.]

V. 80, 1906

ESTABLISHED 1832.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

R. M. VAN ARSDALE, Proprietor.
J. S. BONSALL, Business Manager.

Editors { R. V. WRIGHT
E. A. AVERILL

Published Monthly at 140 Nassau Street, New York.

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III.

THE STOREHOUSE.

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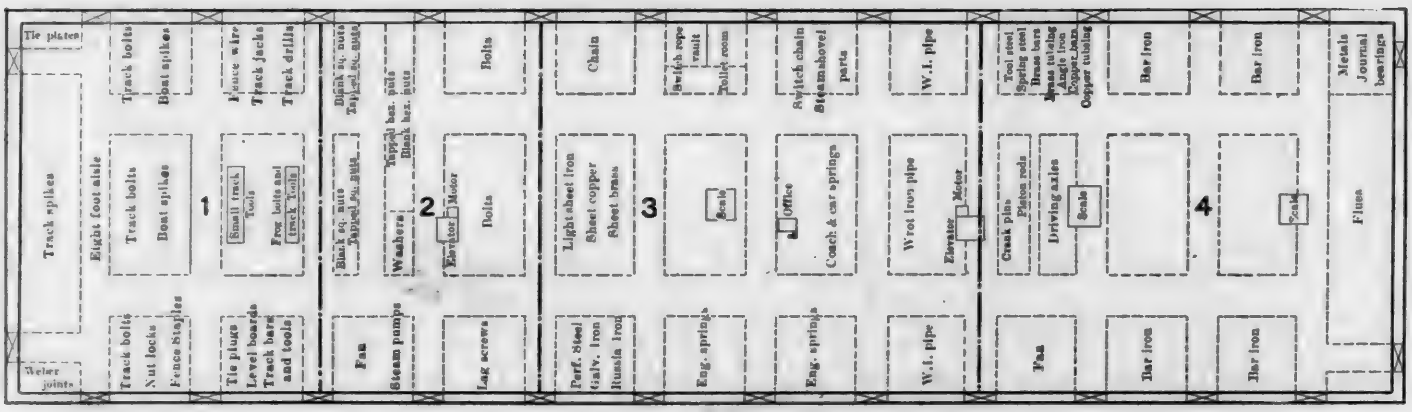
STOREHOUSE, STORAGE PLATFORM AND TRAVELING CRANE.



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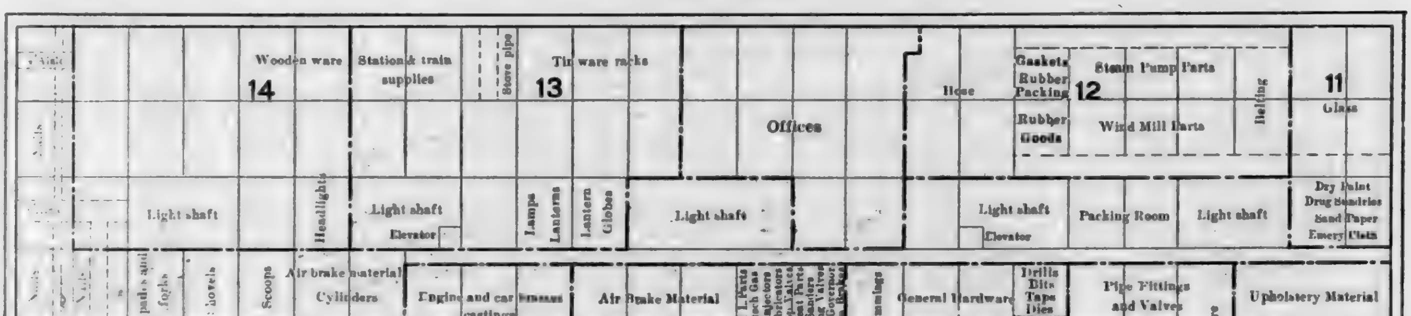

Plan 2nd Floor

PLANS OF FIRST AND SECOND FLOORS OF STOREHOUSE, SHOWING SECTIONAL ARRANGEMENT OF MATERIAL.

The heavier material, such as large castings and plates, is stored on a platform, 134 ft. 4 ins. wide and 400 ft. long, at the east end of the storehouse, which is served by a five-ton crane with an 80-ft. span. A delivery track extends along either side of this platform and the storehouse, as shown on the plan of the shops on page 390 of the November issue. The 17 ft. 6-in. platforms, which extend along either side of the storehouse and between it and the delivery tracks are kept

SECTION 12, SECOND FLOOR.

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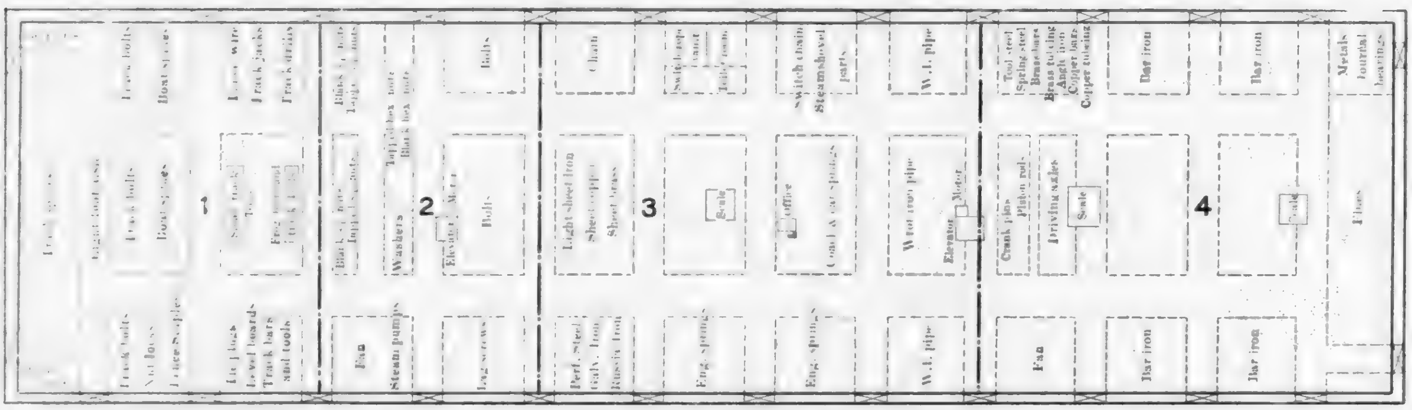
clear of material and are used for loading and unloading purposes only. The platforms and the first floor of the storehouse are 4 ft. above the top of the rail.

The storehouse is intended to furnish material promptly and economically, and should be designed with that end in view. It is the jobbing house of the railroad. As shown in the plan views of the first and second floors, the material in the Moline storehouse is arranged in sections; section 1, for instance, contains roadway material; section 2, bolts, nuts, washers and lag screws; section 10, upholstery material, etc. Each section is in charge of a man who is thoroughly familiar with the material in his section; for instance, a practical track man has charge of the roadway material in section 1; section 2, on the other hand, does not require a man with much skill or experience, but rather one who can handle the heavy work; section 10 is in charge of a man who is thoroughly familiar with the material used in the upholstering department. The third floor of the storehouse is used for storage purposes. The

STOREHOUSE, STORAGE PLATFORM AND TRAVELING CRANE.



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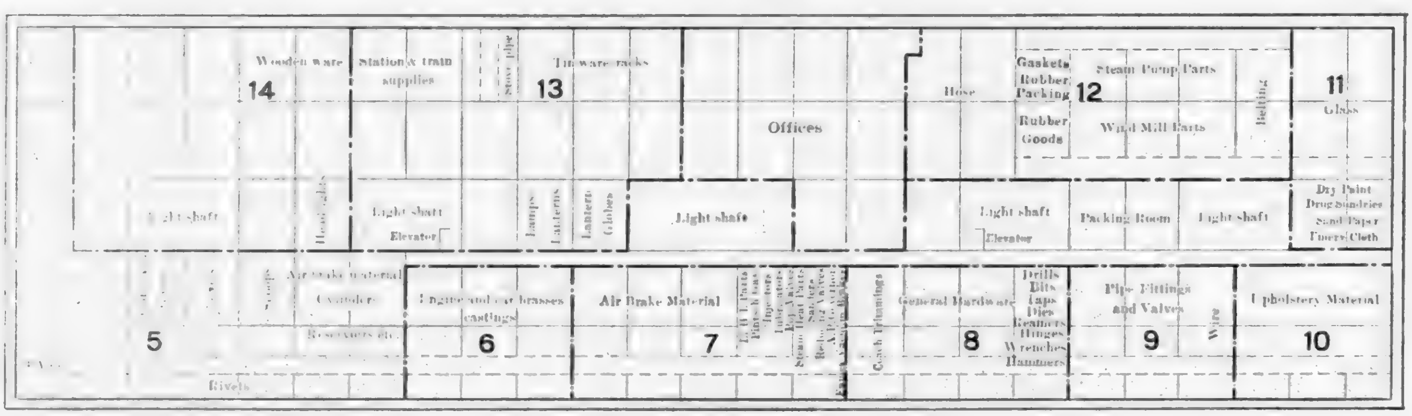

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SECTION 4, FIRST FLOOR.

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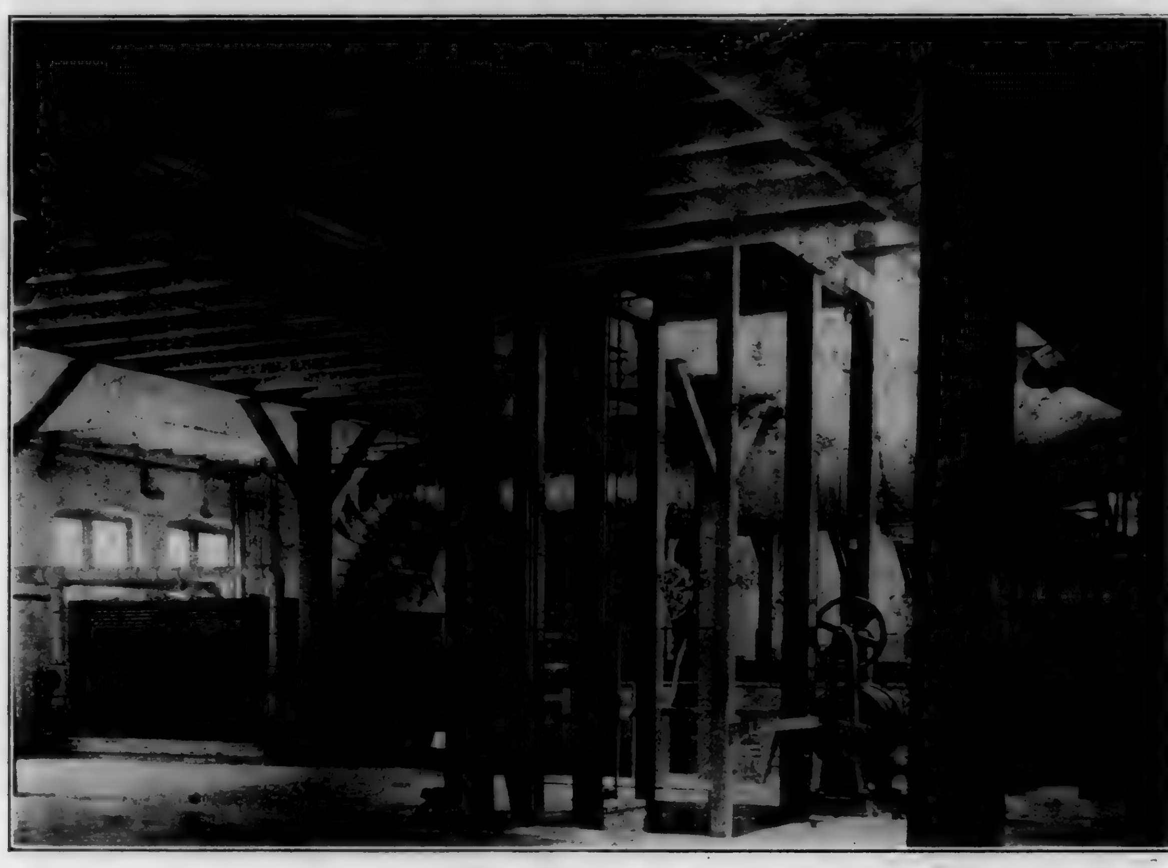
The storehouse is intended to furnish material promptly and economically, and should be designed with that end in view. It is the jobbing house of the railroad. As shown in the plan views of the first and second floors, the material in the Moline storehouse is arranged in sections; section 1, for instance, contains roadway material; section 2, bolts, nuts, washers and lag screws; section 10, upholstery material, etc. Each section is in charge of a man who is thoroughly familiar with the material in his section; for instance, a practical track man has charge of the roadway material in section 1; section 2, on the other hand, does not require a man with much skill or experience, but rather one who can handle the heavy work; section 10 is in charge of a man who is thoroughly familiar with the material used in the upholstering department. The third floor of the storehouse is used for storage purposes. The



ARRANGEMENT OF STURTEVANT HEATING SYSTEM ON THE FIRST FLOOR.

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Section	Am't.	Description.	Time Rec'd.	Time Del.	Time Elapsed
2	25	Patch Bolts ⅞	10.30	10.42	12
	20	" " 15/16	10.00	10.10	10
	48	Lag Screws ½x5¼			
	48	" " ½x4½			
	24	" " ½x3½			
	24	Carriage Bolts ⅝x12	1.48	1.52	04
	24	" " ⅝x8			
	4	Washers ½			
3	2	Sheets No. 16 Tank Steel.	10.10	10.25	15
	2	Slide Springs	1.45	1.55	10
4	2	Bars Ordinary Tool Steel sq. 1½	8.00	8.05	05
	1	Bar Ordinary Tool Steel sq. 1¾			
	1	Bar Com. Iron 1½x⅝	11.50	11.57	07
	1	" " " 1½x⅝			
	1	" " " 1½x⅝			
5	75	Cone Head Rivets ½x1¼	3.30	3.37	07
	50	" " " ⅝x1¼			
	50	" " " ½x1			
6	4	Bushings No. 1407	1.53	2.00	07
	4	" " 1407			
8	50	Rd. Head Iron Screws ½ No. 24			
	50	Rd. Head Iron Screws ½ No. 24	4.40	4.45	05
	50	Rd. Head Iron Screws ½ No. 24			
11	2 lbs.	Yellow Potash	2.55	3.00	05
12	2	Sewell Steam Heat Hose 1⅝x24			
	4	Sewell Steam Heat Hose 1⅝x24	3.32	3.39	07
	2	Sewell Steam Heat Hose 1⅝x24			
17	8	Brake Shoes A. B. 549	9.10	9.20	10
	8	" " Keys			

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SECTION 7, THIRD OR STORAGE FLOOR.

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5	Asbestos, Nails, Paper, Rivets, Rope, Stoves, Shovels.
6	Rough and Finished Brass Castings, except Journal Bearings.
7	Air Brake, Bell Ringer, Electric Headlight, Injector, Pop Valve, Pintsch Gas, Sander, Steam Heat Material.
8	Shelf Hardware, Shop Tools, Metallic Packing, Lubricators and Gauge Glasses.
9	Pipe Fittings, Wire and Wire Cloth.
10	Upholstery Material, Carpets, etc.
11	Glass, Drugs, Paints, Sundries.
12	Water Service, Rubber and Leather Goods.
13	Station and Train Supplies.
14	Tool and Supply Boxes, Tables, Desks, etc.
15	
16	
17	Brake Beams, Bolsters, Car Castings and Forgings, Axles, Couplers, etc.
18	Cylinders, Engine Castings, Cabs, Tires, Firebox and Tank Steel.
19	Shop Lumber, All Kinds.
19B	Bridge and Building Lumber, Piling, etc.
20	Oil House Material, Oil, All Kinds, Varnishes, etc.
21	Coal, Coke, Brick and Foundry Supplies.
22	Scrap, All Kinds.

These cards show only the general class of items in each section, and if there is any question as to where a certain article may be found it is only necessary to refer to a detail index in the booth. At the present time thirty-seven telephones are in use, the central being located in the storehouse offices. Provision is made for the installation of 100 telephones.

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The storehouse is equipped with two automatic electric elevators, each of 5,000 lbs. capacity. The building is heated by the Sturtevant hot air system; exhaust steam from the power house with Webster vacuum return is used for heating the steam coils. The Sturtevant fans are driven by Crocker-Wheeler shunt wound 25-h.p. motors through Morse silent chain. In addition to the fire hydrants and fire apparatus the building is equipped with a sprinkler system. We are indebted for information to Mr. C. A. Seley, mechanical engineer, and Mr. H. C. Pearce, general storekeeper.

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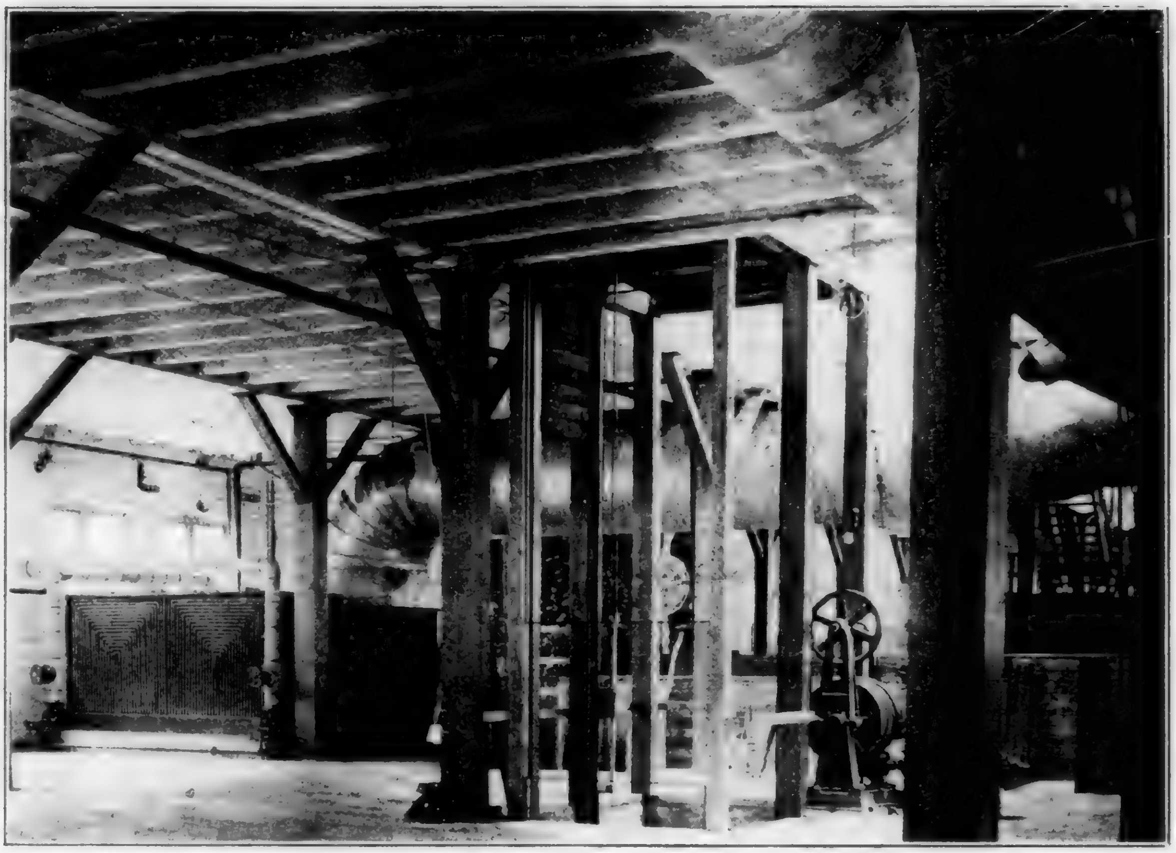
In 1805 the world had not a single steamer upon the ocean, a single mile of railway on land, a single span of telegraph upon the continents, or a foot of cable beneath the ocean. In 1905 it has over 18,000 steam vessels, 500,000 miles of railway and more than 1,000,000 miles of land telegraph, while the very continents are bound together and given instantaneous communication by more than 200,000 miles of ocean cables, and the number of telephone messages sent aggregate 6,000 millions annually, one-half of them being in the United States alone,. The world's international commerce which a single century ago was less than two billions of dollars, i now 22 billions, and the commerce of the Orient, which was less than 200 million dollars, is now nearly 3,000 millions.—*Mr. O. P. Austin, National Geographic Magazine.*



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LOCOMOTIVE CYLINDERS.

BY HAL. R. STAFFORD.*

While no attempt will be made in this article to trace the history of locomotive cylinder design from the simple, primitive castings used on Stephenson's "Rocket" or the "Stourbridge Lion," which had nothing in common with those of to-day, except that they were made of cast iron—a practice which we have been unable to improve; to the 16 x 24 in. cylinder of our father's time, and, finally, to those of the 24 x 32 in. freighter of the present day—enough will be said to prove that we are to-day confronted with many problems besides those incident to mere increase in size.

The accompanying illustrations are typical of modern practice. Fig. 1 is a 22 x 32 in. slide-valve cylinder for a consolidation freight engine, and Fig. 2 is a 20 x 24 in. piston-valve cylinder, also for a consolidation engine. Both are of the "half-saddle" type, which has become practically the standard in this country, although several important roads still use the separate saddle type to a great extent.

In the separate saddle cylinder, as the name implies, the barrel and valve seat are cast separately from the saddle, the frame being "slabbed" to pass between them. This necessitates several extra joints in the steam connections, with consequently greater liability of leakage of steam to the atmosphere. Trouble is also experienced in preventing the working of cylinders on the frame, in spite of the great number of bolts and large frame keys now used. The principal advantage of this design is simplicity of castings, though, in the present day of advanced foundry practice, no difficulty is met with in casting cylinders with the half-saddle attached.

Referring to the commonly accepted type, the term cylinder in railway parlance to-day includes, besides the cylinder barrel and the valve seat, the "frame fit," or face for attaching to the frame, and the "saddle" by which it is secured to and supports the front end of the boiler by attachment to the smokebox. Given the diameter of the cylinder, length of stroke, height and radius of boiler, frame centers, cylinder centers, etc., the cylinder designer is asked to furnish a suitable casting, connecting the boiler rigidly to the frames and carrying the cylinder barrel, all steam passages to be as well protected from the atmosphere as possible, with a minimum of weight and a maximum of strength.

The cylinder shown in Fig. 1 has a somewhat high saddle, necessitated by its use under a boiler with a Wooten firebox. It will be noted that the steam inlet pipe is kept separate from the exhaust for the greater part of its length and, though its one side forms part of the outside wall, the saddle at this point is covered with magnesia lagging and jacketed with sheet iron. Builders sometimes go a little farther, carrying a lightening core between the steam pipe and the outside wall and another between the steam and exhaust pipes, under the frame rail; but as a certain amount of "dirt" washes from each of these small cores when the casting is poured, rising to the highest point in the mould, which is the barrel (cylinders being cast upside down), the necessity of having good metal at this point makes the multiplication of small lightening cores an undesirable practice. To avoid the difficulty of dirty barrels and also to keep the mould full as the metal shrinks, risers are cast upon the cylinder-cock bosses, and very frequently upon the frame fit, which is another region of frequent trouble. These are shown by the heavy dotted lines in Fig. 1.

Cylinders are gated at the back, where they bolt together, near the bottom of the mould. As the metal rises, it should have a free flow to all points, particularly to the barrel and frame fit, where, by the junction of many walls, there are apt to be masses of metal, which must be fed before it has time to become too cool. For this reason a horizontal wall, "x," Fig. 1, is often webbed around the steam and exhaust pipes, which forms a direct passage for the metal without its flowing in a circuitous route around the outside wall, or "stretcher."

*American Locomotive Company, Schenectady, New York.

The principal points to be kept in mind in arranging steam and exhaust passages in the saddle, are to avoid flat walls, to provide a direct route free from sudden bends, and of as nearly constant area as possible for the passage of steam. The exhaust, in particular, must have no large pockets to form eddies, but must be guided directly to the nozzle. The first piston-valve cylinders were particularly faulty in this respect, the exhaust filling much of the room which, in the later designs, is thrown into the lightening space. This large reservoir acted as a muffler on the exhaust, the sound being much the same as produced by a very leaky valve.

The proportions of cylinder barrels are subject to great variation among different builders. A common fault is too short a barrel, bringing the ports too close to the ends. This is a vital error, as an accident causing the breakage of a cylinder-head is apt to tear away this part of the flange, making a break that is almost impossible to repair. The design in Fig. 1 shows liberal metal at this point. Thickness of the barrel in locomotive cylinders is seldom found by rule, as in stationary and marine work, but is usually fixed upon with a view to boring out and bushing to original size when worn. It is becoming quite common practice to cast piston-valve cylinders of soft, easily machined iron of low shrinkage and to bush with much harder iron; by this means, all wearing surfaces are made more lasting, with less danger from shrinkage cracks, due to use of hard iron. With slide-valve cylinders, this would necessitate the use of a false valve seat in place of the piston valve bushing in the other case, and so is seldom done.

In bolting cylinders together, a double row of bolts should be used on cylinders of 18-in. bore and upward, and it is good practice to make several of the lower bolts, where the stress is greatest, of larger diameter than the rest. Bolting to the smokebox should also be in a double row, and the bolting flange should be of liberal thickness. It is hard to estimate the enormous strain borne by these bolts during severe shocks, due to switching or slight collisions, with the boiler carried at the height shown in Fig. 1. For the same reason, a liner, not less than ½ in. thick, is always used to reinforce the smokebox sheet, extending well up the sides and usually the full length of the smokebox. The opening in the liner and the smokebox sheet for the passage of steam and exhaust pipes should be no larger than is necessary, but care should be taken in designing engines with single bar, continuous frames to see that the steam pipe boss on the cylinder is not too high to prevent its passing through this opening when the cylinder is withdrawn horizontally, otherwise it will be necessary to separate the frame from the boiler for its entire length when removing a cylinder.

Bolts to the frame should be so located that the nuts can be reached with a wrench, instead of being tightened with a set, as is often done. For that reason, a few well-placed bolts of large size are to be preferred to a number of small ones badly located. There should be at least one vertical bolt in each end of the frame fit, although these have been omitted in some recent piston-valve designs. Vertical bolts can not be of so large diameter as horizontal bolts, since the width of the frame is limited, while the depth may be increased to almost any extent at this point to make up for the metal removed by bolt holes. Top rails need not be bolted horizontally and vertical studs are of little use, all dependence being placed upon one or two vertical bolts at each end of the frame fit, with a key at the front and crossties shrunk on the frames at the front and back of the cylinders.

Cylinder-head studs are usually spaced too far apart to prevent springing of the head between holes. For a boiler pressure of 200 lbs. and upward, the pitch should not exceed 3¾ in. It will be found that ⅞ in. studs, instead of 1 in., as are usually applied, will be amply strong with this spacing. A fiber stress of 7,000 to 8,000 lbs. is on the safe side, taking the diameter to the middle of the grinding joint as the surface on which the pressure acts. The same is true of steam chest studs on the slide-valve cylinders—smaller studs, closer together—although here we are limited by the stuffing box on

the chest passing between the studs. The fact is often overlooked that fiber stress on the studs is not the only thing to be taken into consideration. We seldom hear of a steam chest cover blowing off, but we do see covers and cylinder heads leaking because of the studs being spaced too far apart.

The piston valve is daily growing in favor, in spite of prejudice. As regards the cylinder casting, it has many advantages. The walls lend themselves more readily to curved lines than do those of the slide valve, the avoidance of flat walls exposed to steam pressure being one of the most important things to be considered in cylinder work. Designs are often seen with flat walls of great area stayed with tie pieces and ribs. These are a menace to the casting, as they generally either crack off or pull out a piece of the wall, according as they are heavy or light, in comparison with the adjoining metal. As piston valves can be made of any desirable length, outside admission valves, the pressure exerted on the area of the valve stem must be counterbalanced by extending the stem through a stuffing box on the front end also. Then it makes a more free exhaust. When exhaust takes place toward the inside, the tendency is to flow first to the opposite end, where it is caught in the cup of the opposite bushing, striking that end of the valve and causing a jumping which is very noticeable when there is lost motion in the connections. Then, after expending most of its energy, it finds its way to the outlet. With inside admission valves, the shape of the steam chest cover can be made such that the exhaust finds a smooth course, free from eddies, to the nozzle.

With direct motion, the valve chest is placed almost directly above the frame, but should not be in too close proximity to the heavy mass of metal forming the frame fit. As has been said, this is one of the worst places for spongy metal, particu-

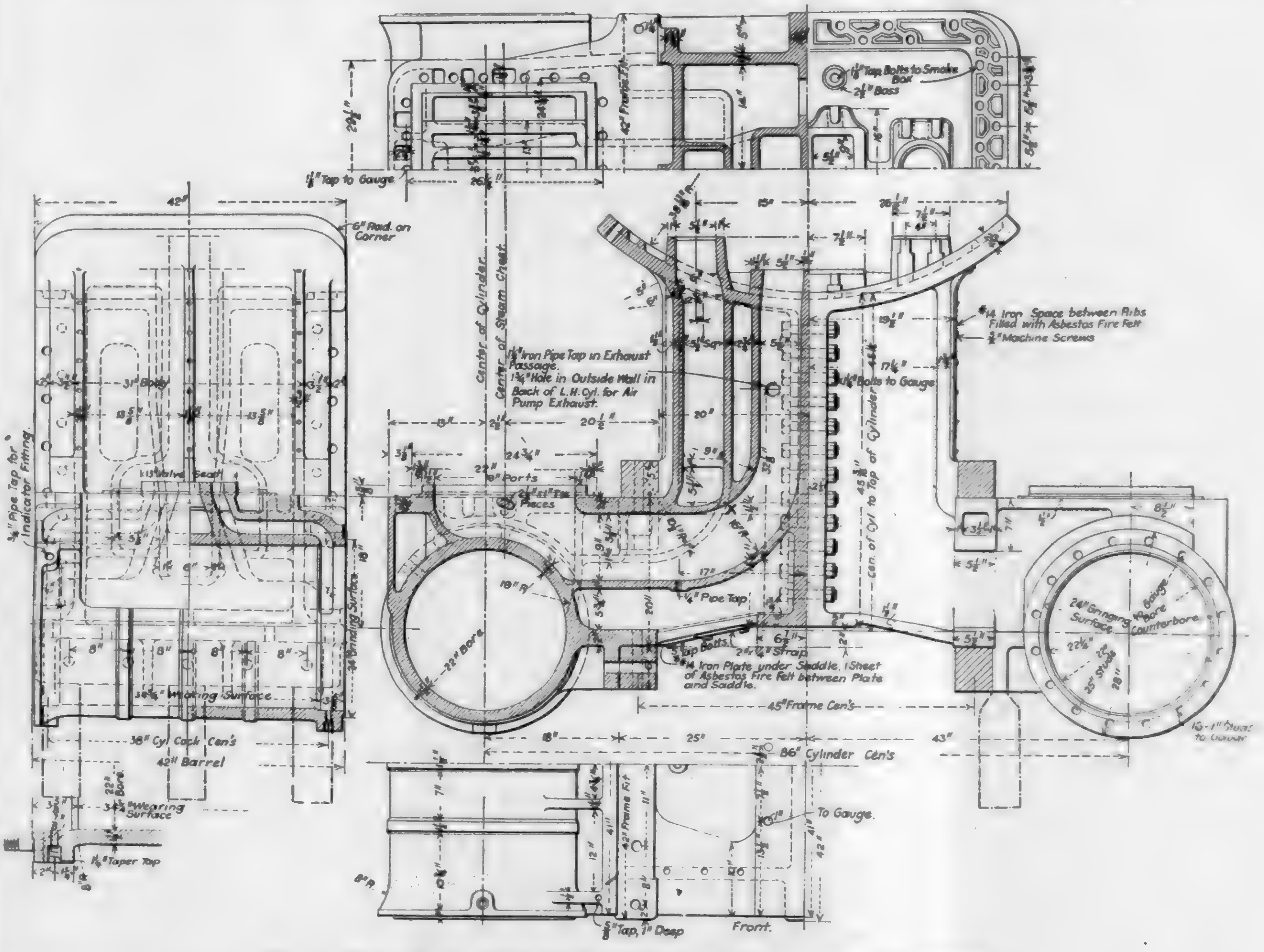


FIG. 1—22 BY 32 IN. SLIDE VALVE CYLINDER FOR CONSOLIDATION LOCOMOTIVE.

the steam ports can be made very short and direct. For this reason, also, the steam chest should be placed as close to the bore as will allow the barrel flange to be turned for the head casing. A reduction of clearance to 7 or 8½ per cent. is thus easily secured, and even less can be obtained by a sacrifice of other desirable features.

The piston-valve cylinder, shown in Fig. 2, is for inside admission, with direct valve motion. For indirect motion, with either inside or outside admission, it would be necessary to place the valve chest almost directly above the cylinder barrel, as this would bring the valve stem in the same relative position as on a slide valve engine. Most piston-valve cylinders are arranged for inside admission, as this has several advantages: first, it brings the exhaust on the ends, lessening packing troubles—many roads use only hemp packing on piston valve stems. It makes the valve perfectly balanced, while, with larly in piston-valve cylinders, and great care must be taken to avoid the massing of walls at this point. It will be observed in Fig. 2 that the steam ports pass very close to the frame, which is a source of danger, unless the metal is evenly distributed. The risers, previously mentioned, are particularly necessary on piston-valve cylinders. Another precaution is shown at "x," Fig. 2, a portion of the face of the frame fit over the port being set back about ½ in., so that, in planing, this is left untouched, on the theory that the "skin" of a casting is most likely to prove of sound metal.

Do not tie internal walls together with ribs in any type of cylinder, but leave them all possible freedom to expand and contract with changes of temperature relying on the box of the saddle for strength to resist the stresses due to the thrust of pistons, the racking of frames on curves, etc. It will be found that metal in the outside walls of the saddle is in the

best possible position to sustain these strains, and the addition of extra walls only adds weight, as well as endangering the casting. Small tie pieces, "y," Fig. 2, however, are always placed in "opening cores," i.e., steam ports, on account of the long, unsupported portion of the barrel flange necessitated by a wide port. These should run right to the counterbore, forming a guide for the piston rings when placing the piston in the cylinder.

Steam chests of piston-valve cylinders can readily be made self-draining, as in Fig. 2, while slide-valve chests must be kept clear of water by waste cocks operated preferably by a separate lever from that of the cylinder cocks, that they may be kept closed while running with the cylinder cocks open. This avoids the drainage of oil from the valves and pistons along with the water.

In the foundry also the piston-valve cylinder has points of superiority. Fig. 3 illustrates a modern method of setting cores in this type of cylinder, in which all steam and exhaust be readily broken up and removed when the casting is cleaned. Each arbor has two or more eyes for the reception of the bolts by which it is joined to the foundation core. This core is made in halves, with half of a hollow cast iron center moulded in each, which central arbor is provided with a number of holes, through which the core bolts pass, with nuts on the inside. These nuts are tightened, securing the cores in place upon one-half of the foundation core at a time; the two are then drawn together by bolts in slotted holes in the end of the hollow arbor.

All joints have now to be treated in the usual manner, "pasted" together and covered with plumbago, a thorough skin drying being given by a gas torch, or other means. Sometimes they are treated to a second baking in a core oven, but this is rarely necessary. The whole is now ready for lowering into the mould. While the making of the cast iron arbors used in this method involves additional expense, the smaller percentage of lost castings, due to cores shifting, and the great

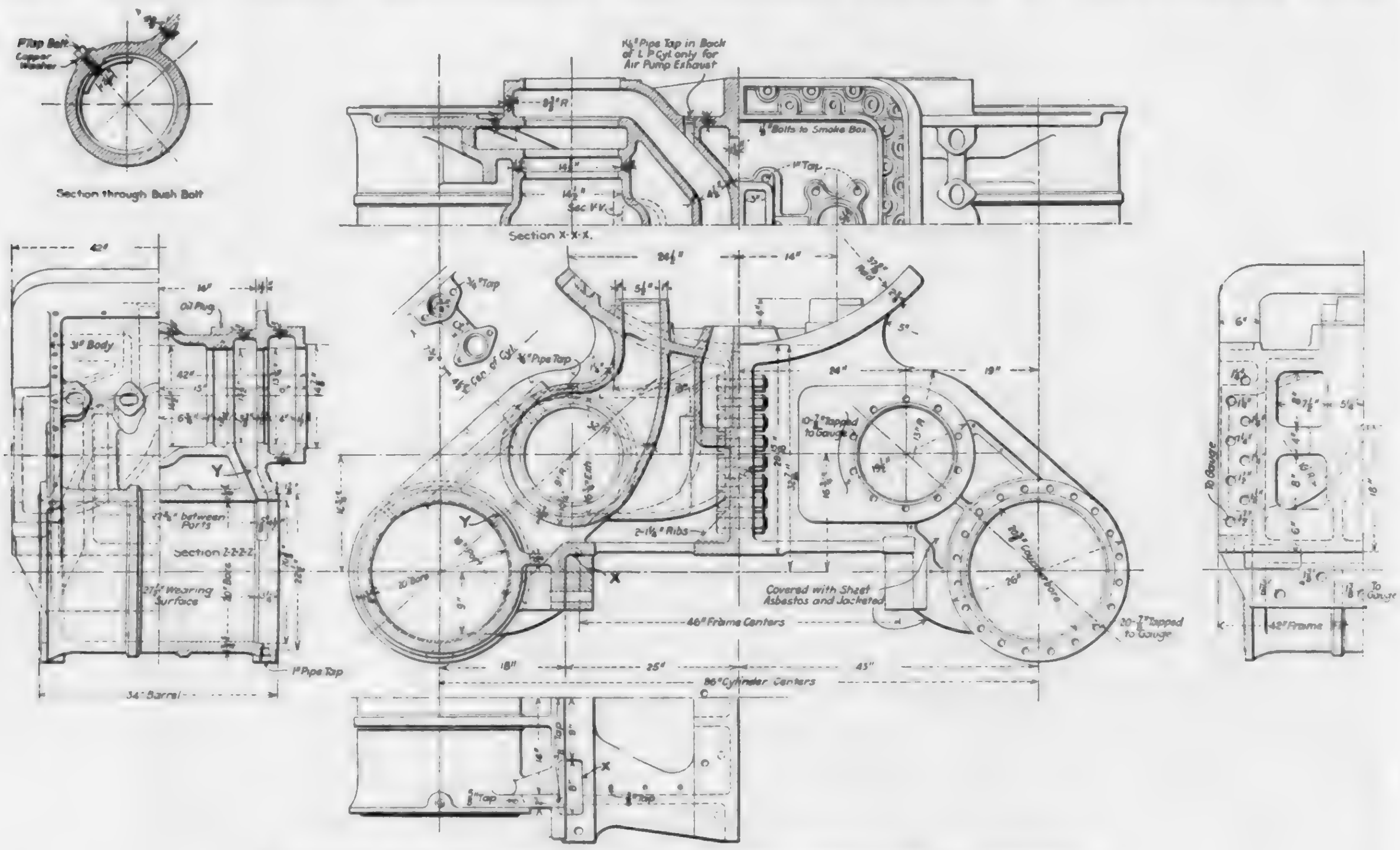


FIG. 2.—20 BY 24 IN. PISTON VALVE CYLINDER FOR CONSOLIDATION LOCOMOTIVE.

cores are rigidly joined together, being lowered into the mould in one piece. In order to do this, great care must be taken to make these cores of such shape that they will clear the lower half of the lightening cores (this means the upper half, referring to drawing), when lowered vertically into the mould. Lightening cores are divided on the horizontal line passing through the center of the steam chest, all between this line and the "deck" being placed in the mould previous to the lowering in of the steam and exhaust cores. This method eliminates all fins and passages where they are removed with difficulty, and often only half disposed of at that. Instances are numerous of old cylinders being broken up after years of service and the discovery made that one cylinder drew its steam supply through an opening no bigger than a knot hole. Many of the mysterious differences between engines of the same class are due to such causes.

Referring to Fig. 3, it will be seen that the cores are assembled on a wooden "horse" and that the steam chest core forms the foundation of the whole structure, to which all other cores are secured by means of the special bolts shown. Each core has a cast iron arbor running through it besides the usual core irons. These arbors must be made light enough to improvement of the quality of the work turned out makes this really the most economical way in the long run.

In the design of new cylinders, the drawing room and the shop must coöperate. To send out the drawing of a radically new type, a drawing which is the product of the engineering department, without consultation with the pattern-maker is to invite trouble—at least, to pile up unnecessary expense. It is also of greatest importance that the engineer does not confine himself to the consideration of design only, but follows the work through the pattern shop and the foundry to see that his ideas are carried out. It is commendable practice to break up a cylinder from each new pattern—one that has proved defective, if there should be one; otherwise, a sound casting, upon which no machine work has been done. The pieces are then carefully checked from the drawing and the thickness noted. Any sharp corners on the steam or lightening cores should call for comment; fillets should be put in the core boxes and not left for the core-maker to attend to. There is a tendency for pattern-makers and core-makers to be on the "safe side"—too far—in calculating the thickness of metal: 1-in. walls becoming 1⅛-in., and 1½-in. walls about 1¾-in. through a system of double allowance for swelling of cores; the pattern

shop makes one allowance, then the core-maker slicks off still more, with the result that castings greatly overrun the estimated weight. Rigid inspection under the drop is the only sure way of detecting these practices.

Compound cylinders introduce so many complications and such infinite variety as to be quite beyond the scope of so brief an article. With these, as with simple cylinders, the design of walls and passages for resisting steam pressure, machinery strains, shrinkage, etc., is more a matter of common sense and experience than mathematics.

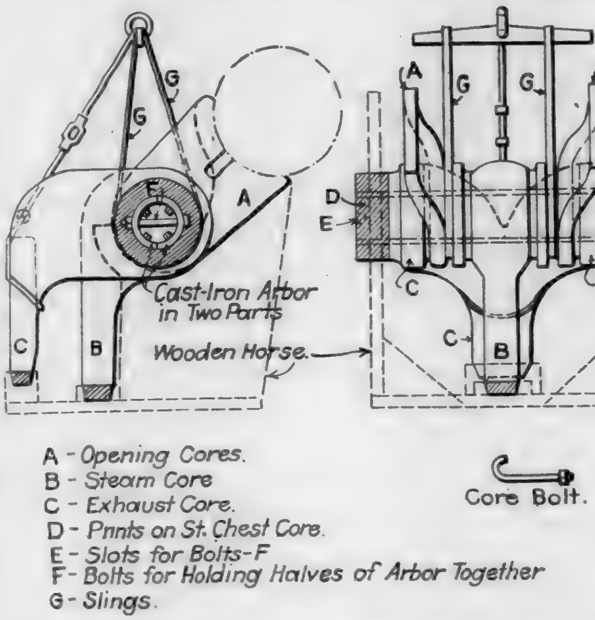


FIG. 3.—METHOD OF SETTING CORES IN PISTON VALVE CYLINDER.

THIRD MAN ON LOCOMOTIVES.

A few years ago a fireman was required to clean his own fires, hoe out the ash pan, spark the front end, and when he arrived at the terminal his labors had just began, for he had the engine to clean inside and out, also brass to scour; while at present he is relieved of the cleaning almost entirely, and with the modern locomotive he has been relieved of the duty of cleaning fires and ash pans and sparking front ends.

The hardship of a fireman at the present day, in our opinion, is not what it is pictured. He has very little to do except to put the coal into the firebox.

If our divisions are too long, making it impossible for one man to cover the division, cut the division in two and have a fresh man on the engine.

In correspondence with a road that tried the experiment of placing the third man on an engine, it was given as their experience that the method was not at all satisfactory. Friction developed right from the start, and, taken as a whole, not much, if any, better results were obtained than with one fireman. The best results have been obtained by making shorter divisions for men firing the heaviest locomotives.

We are not in favor of the third man on the engine in any capacity.—*From a committee report, before Traveling Engineers' Association.*

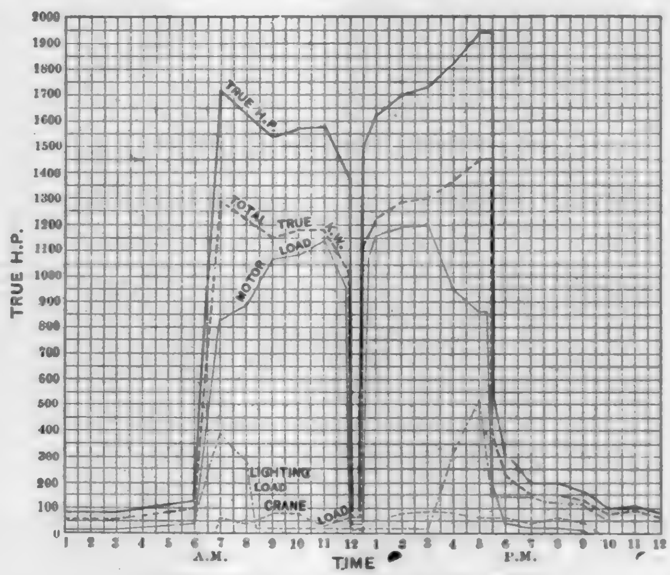
GAS VERSUS STEAM FOR POWER.—Moreover, when we consider that a central station, if equipped with a gas plant, will involve a capital outlay approximately the same as with a steam plant, and that the actual fuel consumption, if worked at full load continuously, will be reduced in the proportion of 100 to 83, and, if, worked with a load factor of 25 per cent., in the proportion of 100 to 35, then we are bound to acknowledge the superiority of the gas system, and adopt it wherever power plants are to work with the highest commercial economy.—*Mr. F. E. Junge in Power.*

POWER DISTRIBUTION, ANGUS SHOPS.

The accompanying diagram shows the distribution of power for December 22, 1904, at the Angus shops of the Canadian Pacific Railway at Montreal, the power house of which was described on page 75 of our May journal. The maximum load was 1,940 h.p., while the average load from 7 a. m. to 5.30 p. m. was 1,560 h.p. The load factor was 80 per cent. and the power factor of the maximum load was 68. For the entire 24 hours the average load was 850 h.p. and the load factor was 44 per cent. The weather was stormy.

The curves were plotted from the hourly indicating wattmeter records taken from the power house report and this accounts for the power being shown as increasing uniformly between 6 and 7 a. m., while as a matter of fact the increase is quite abrupt at 7 a. m. The motor load remains at practically zero up to 6 a. m., when it increases as the motors operating the fans in the blacksmith shop are started and the fires made ready for 7 a. m., at which time the full load comes on, and this gradually increases as the workmen get into the swing of the day's work, until 11 a. m., at which time the large blower motors in the foundries are started. The load drops off at 12 o'clock noon, starts up again at 12.30 p. m., and remains fairly constant until 3 p. m., when it gradually falls off as the men finish their piece work.

During the winter months the full lighting load is switched on at 7 a. m. and gradually diminishes as the day brightens. At 3 p. m. it gradually begins to increase again and reaches a maximum at 5 p. m. The lights used for general lighting are so greatly in excess of the individual machine lights that



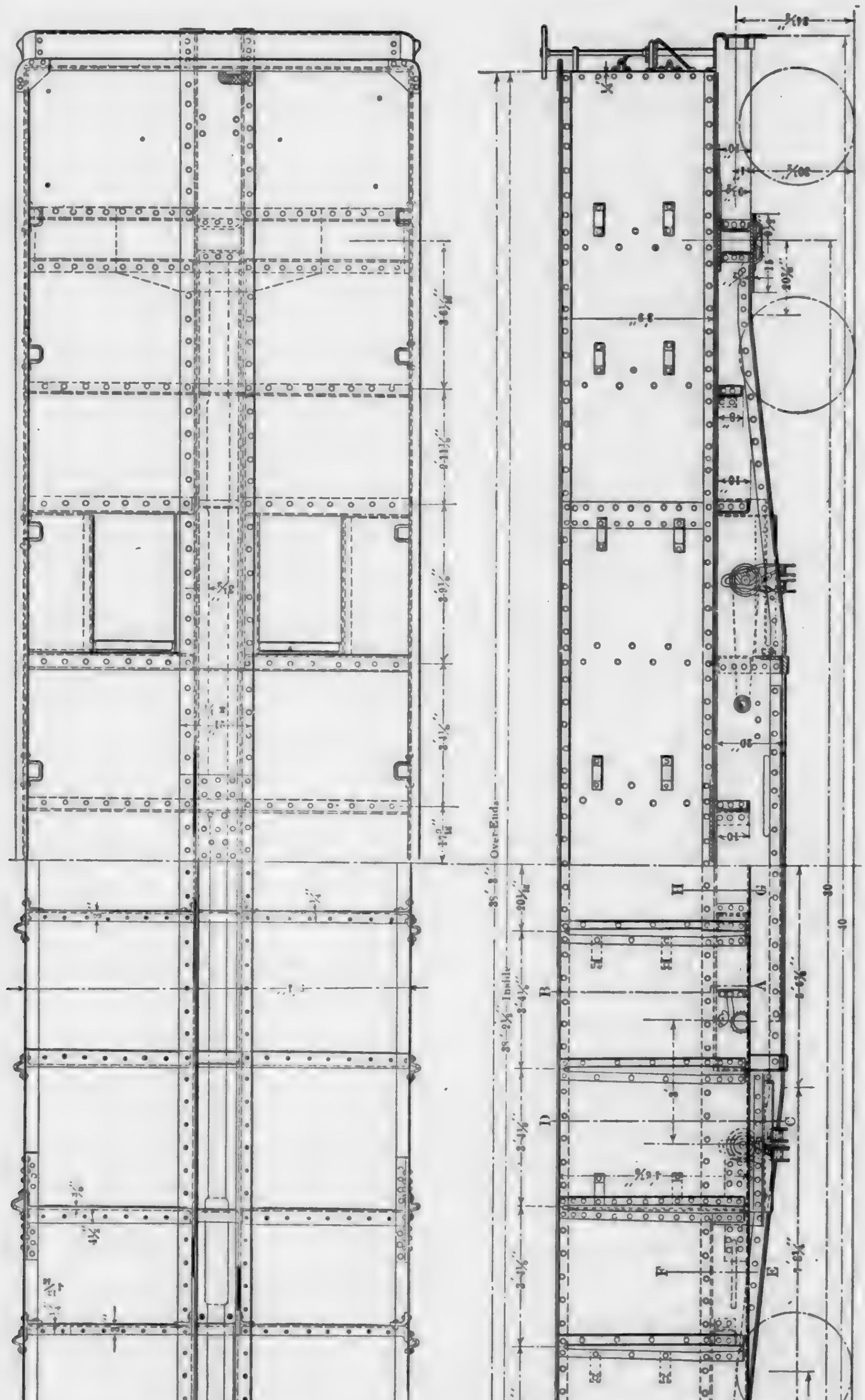
DISTRIBUTION OF POWER—ANGUS SHOPS.

the lighting load is not appreciably affected by the piece workers as they stop work.

The cranes in the erecting side of the locomotive shop are in almost constant use up to 8.30 or 9 p. m. The heavy work is preferably done after hours in order to prevent any delay of the work on the locomotive.

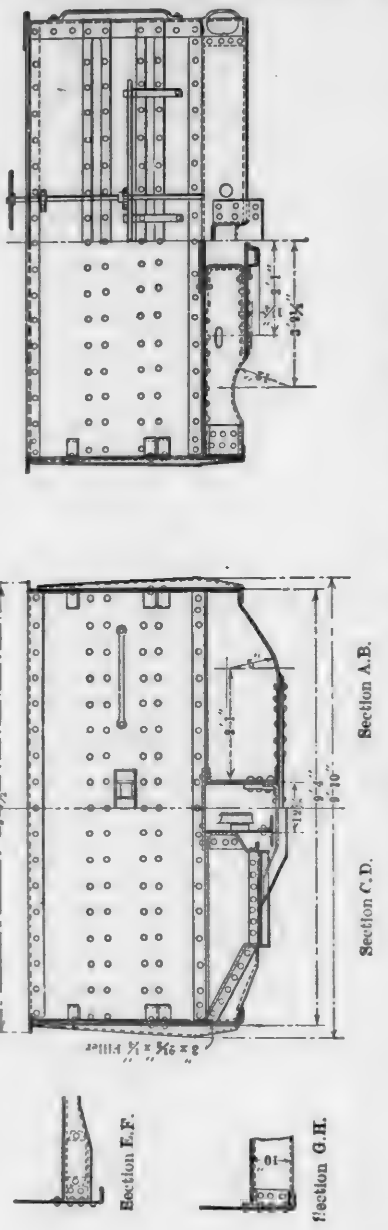
PAINT SHOP FLOORS.—The Master Car and Locomotive Painters Association at their recent convention voted that it was the sense of the convention that either cement or brick floors, if properly constructed, were most suitable for paint shops. The arguments in favor of cement were that it is easily kept clean, absorbs very little water, is easily drained, is hard and smooth, generates very little dust, and the cost of installation and maintainance is comparatively low. Practically the same arguments hold true in the case of vitrified brick laid with cement.

Compressing air to 100-lb. gauge pressure requires approximately $1\frac{1}{5}$ h.p. per cu. ft. of air compressed.

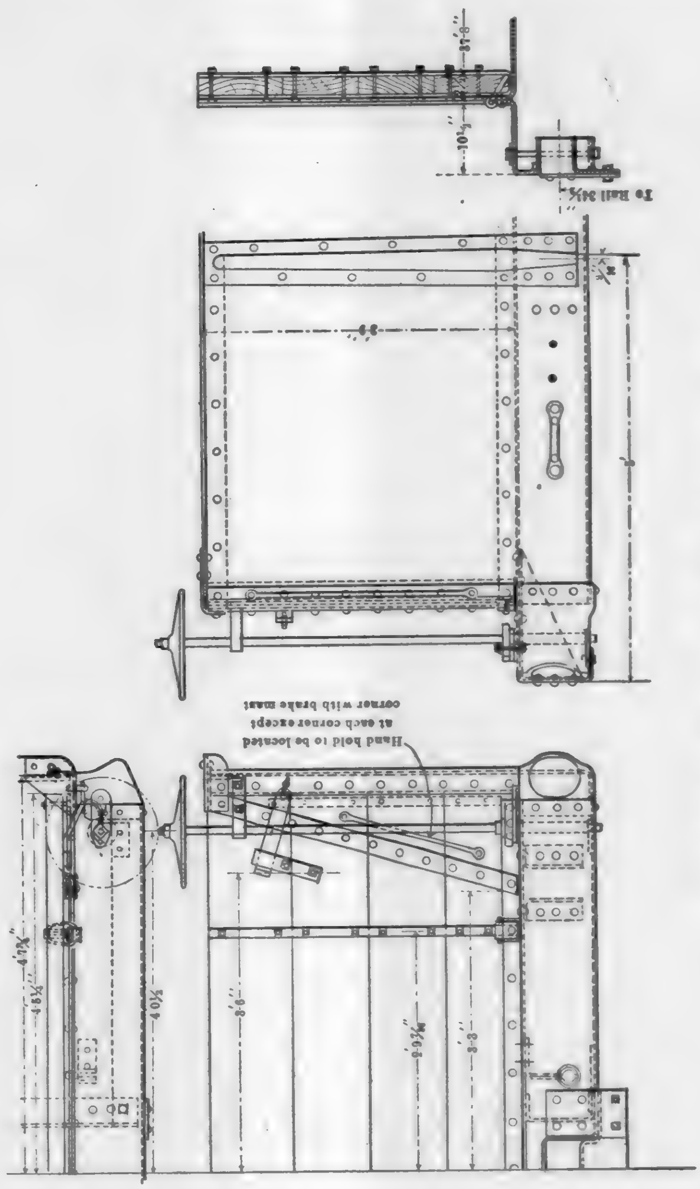


PLAN AND SIDE ELEVATION OF GSA AND GSC 50 TON GONDOLA CARS.

PENNSYLVANIA RAILROAD.



CROSS SECTIONS AND END VIEWS 50 TON GSA GONDOLA CARS.



DROP ENDS FOR GSB AND GSC 50 TON GONDOLA CARS.

STEEL CAR DEVELOPMENT ON THE PENNSYLVANIA RAILROAD.

IX.

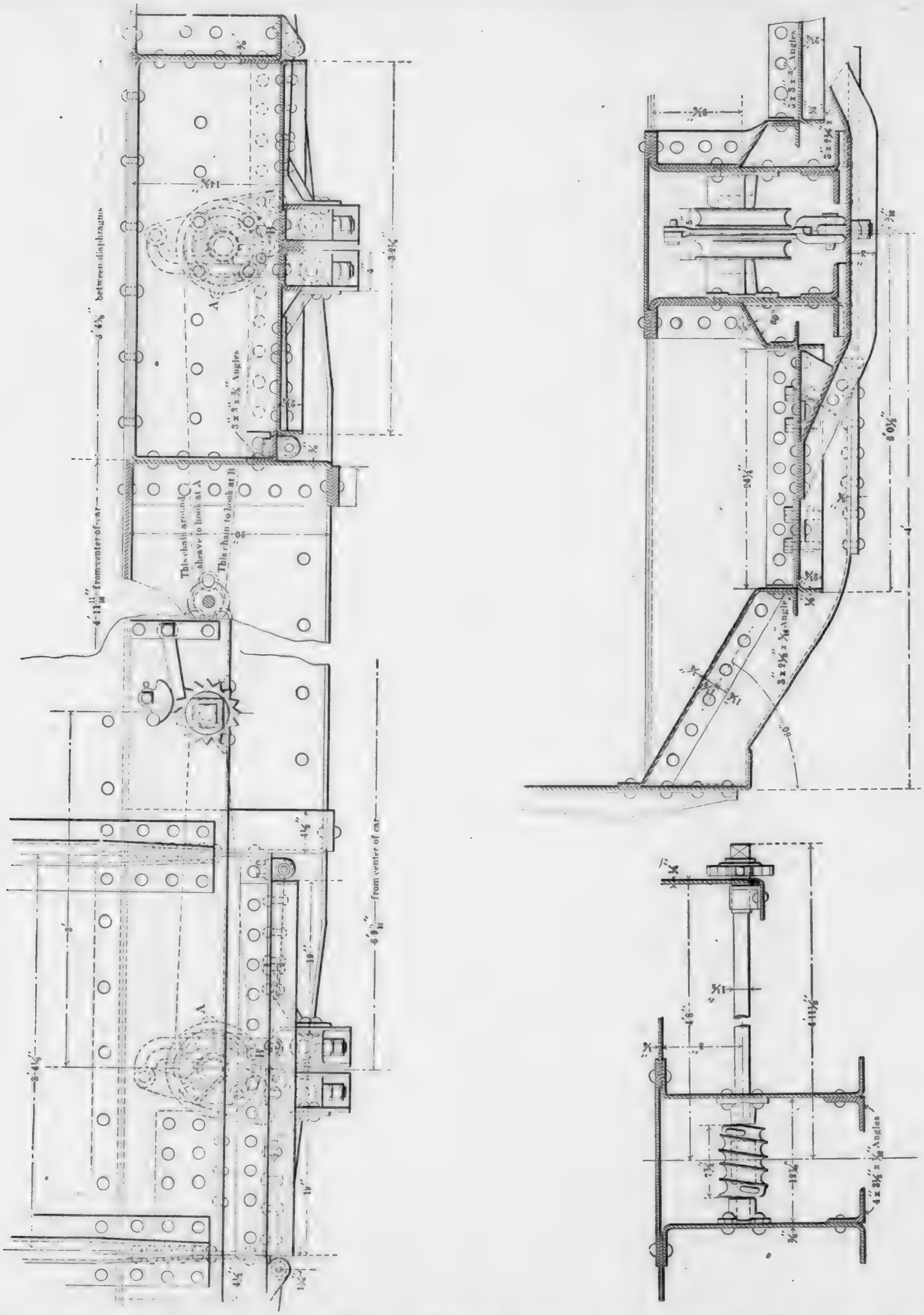
(*For previous article, see page 436, Volume LXXIX.*)

The Gs classes of gondola cars, of which there are four, viz., Gs, GsA, GsB and GsC, have 20-in. center sills as a backbone, but no side sills. These cars were designed for distributed loads. The Gs and GsA classes have fixed ends. The GsB and GsC have drop ends, and the GsA and GsC drop bottoms, all of the Gs sub-classes being generally alike, except as to the ends and the drop bottoms. The weights and capacities of the Gs classes are as follows:

Class.	Capacity, cu. ft. level.	Capacity, cu. ft. heaped.	Light weight.
Gs...............	1331.25	1597.5	38,500 lbs.
GsA...............	1379.25	1645.5	40,000 "
GsB...............	1312.5	1575	38,500 "
GsC...............	1360.5	1623	40,000 "

These cars are not intended for highly concentrated loads, but only for coal and similar loads generally distributed over the full length. The Gs cars are of the same length over end sills and between truck centers as the GR classes. The length inside is 38 ft. 2½ ins., and the width inside 9 ft. 3½ ins., and the sides are 3 ft. 9 ins. high. The center sills are similar to those of class GR., except that they are not quite as deep. In place of side sills the side sheets are extended 10 ins. below the floor of the car and are flanged inwardly at the bottom. The cross members of the underframe are in the form of pressed steel diaphragms which are riveted at their ends to the side plates. The side and end sheets are of ¼-in. steel with coping angles at the top and stiffened at the sides with 10 pressed steel stakes reaching down to the bottom of the side sheets, where they are riveted to the ends of the cross members. The drop ends of the cars which are provided with these ends are of 2½-in. plank. The drop bottom mechanism for the GsA and GsC cars is operated by the Simonton operating device, which is illustrated in one of the engravings. The GsA design is fitted with coke racks, which are also illustrated in one of the engravings. The center sills provide for the Westinghouse friction draft gear arranged between them, the same arrangement being used on all the Gs classes. For the purpose of illustration, the general drawings of the GsA and GsC classes are used, the draft gear for all four classes, the drop ends for the GsB and GsC, the coke rack for the GsA and the drop doors for the GsA and GsC.

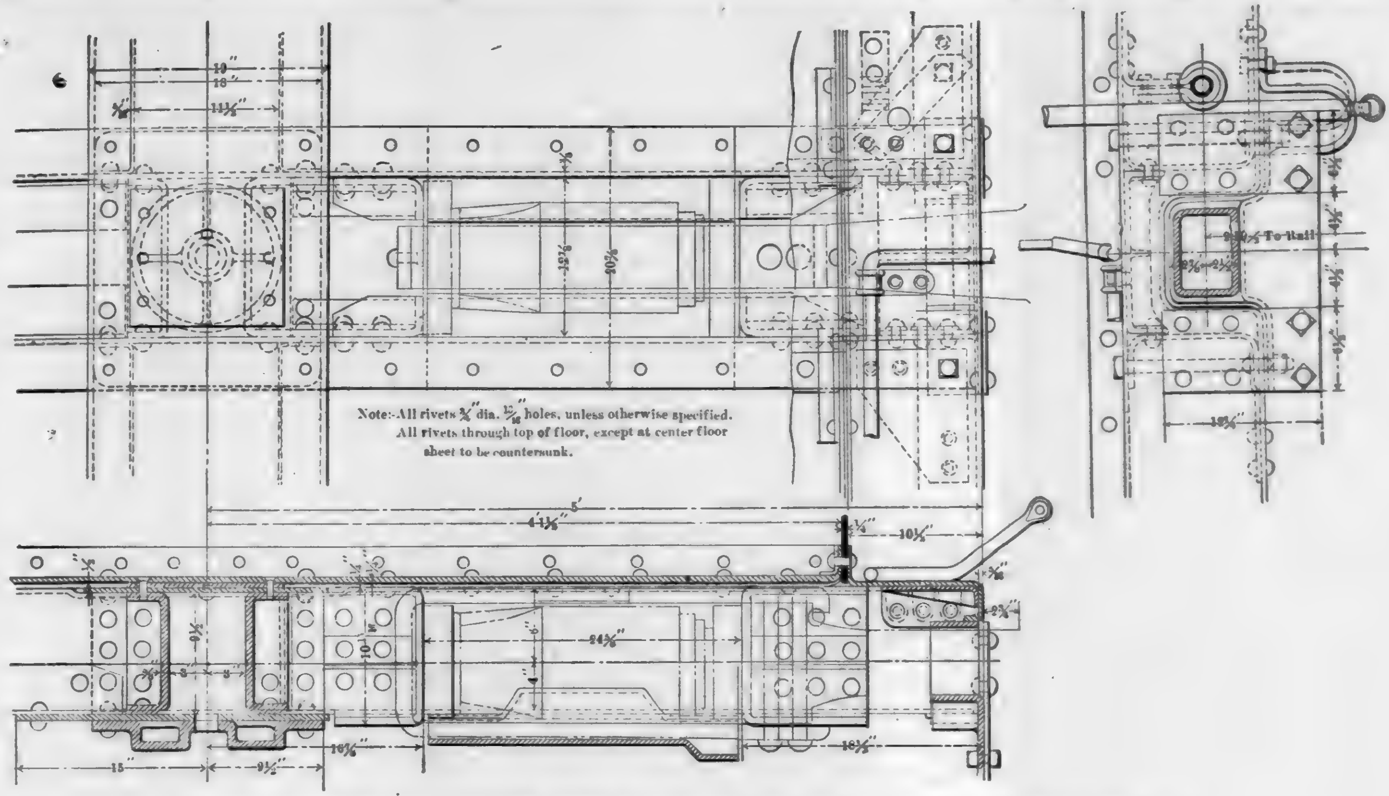
For convenience in reference descriptions of the steel cars of the Pennsylvania Railroad will be found in this journal as follows: October, 1903, page 352; November, 1903, page 402; December, 1903, page 435; January, 1904, page 3; June, 1904, page 209; May, 1905, page 148; October, 1905, page 358; December, 1905, page 436.



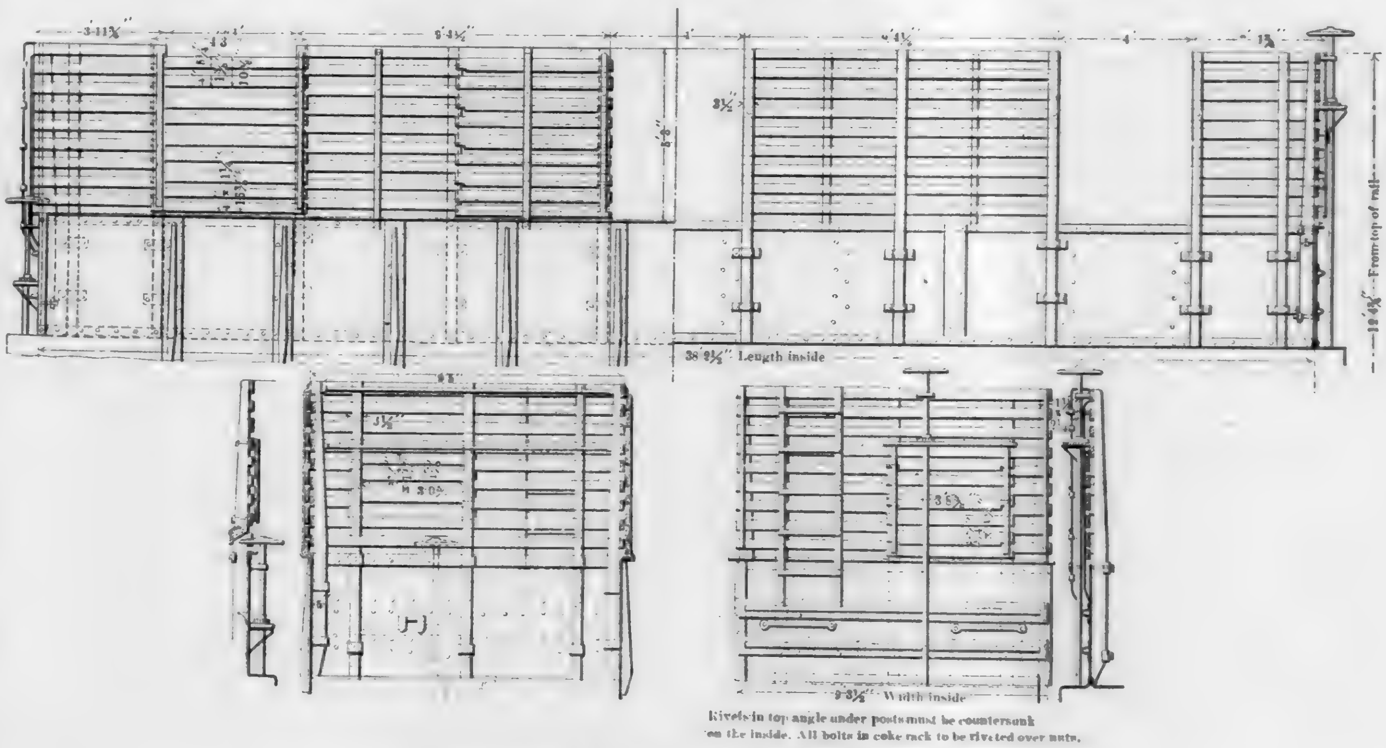
GENERAL ARRANGEMENT OF DROP DOORS FOR GSA AND GSC 50 TON GONDOLA CARS.

PENNSYLVANIA RAILROAD.

Passenger Traffic in New York.—When it is remembered that the Manhattan elevated and subway systems alone, on but a little over fifty miles of road, carry two-thirds as many passengers as do the steam railroads of the United States on over 200,000 miles, it needs no demonstration to show that the number of passengers interchanged with the Grand Central Station, the terminus not only of the New York Central system, but of the New England railroads as well, does not constitute a large percentage. Even in London, where the facilities are inferior to an American city, the board of engineers in their report advising the royal commission show that one trolley terminus, where the lines, through opposition, are compelled to stop short of ultimate destination, discharges and receives more passengers than are similarly handled at six large railroad passenger stations combined.—*W. B. Parsons, before Purdue students.*



APPLICATION OF WESTINGHOUSE FRICTION DRAFT GEAR TO GS, GSA, GSB AND GSC GONDOLA CARS.



APPLICATION OF COKE RACKS TO GSA GONDOLA CARS

LEAKAGE THROUGH SLIDE VALVES.—In the report of the Steam Engine Research Committee of the Institution of Mechanical Engineers (England) the following conclusions are given concerning elaborate tests on the leakage of steam through slide valves: (1) That leakage through the slide valve, quantitatively determined the first time, is shown to be practically independent of the speed of the sliding surface, directly proportional to the difference of pressure between the two sides of the valve, and, to an approximate extent, inversely proportional to the over-lap of the valve. (2) That even with well fitted slide valves the leakage may represent more than 20 per cent., and is rarely less than 4 per cent. of the total steam entering the cylinder.

REQUISITES OF A SUCCESSFUL ENGINEER.—Master every detail of the work you are responsible for until you understand how it should be done and why. Then shed that detail as fast as you can on your subordinates. Aim always that you shall know at least as much, if not more, about the work than any subordinate; that no one under you shall long or permanently know more that is important about it than you. Get as big men under you as you can, but try always to be bigger yourself, and if that implies fresh study and fresh work, do it. Through all your work, and especially if you are called to executive positions, stand squarely for what is right; for integrity, straightforwardness and honest dealing.—*Henry R. Towne at Purdue University.*

ECONOMICAL LOSS IN ELECTRIC TRANSMISSION.

BY G. R. HENDERSON.

Nearly twenty-five years ago, Lord Kelvin pointed out that, considering the annual charge on invested capital, the most economical section of an electrical conductor is that for which the annual cost of energy wasted in transmission is equal to the annual interest and depreciation on that part of the cost of transmission which is proportional to the section of the conductors. The great number of plants for electrical transmission put in nowadays by railroads, makes a clear understanding of this proposition very interesting and important. Particularly is this the case when a definite and fixed quantity of work is to be done at the end of the line, such as driving a pump by means of an electric motor.

In the solution of this problem, there are three principal factors to be determined, the cost of the transmission line, the initial cost of the plant, and the cost of operation. If we consider such transmission to be made without any line losses whatever, it is evident that our generating plant would only have to be large enough to deliver the power needed at the consuming end, and that the cost of operation would cover the same amount. No matter what the size of conductors used (within reasonable limits), the same number of poles and insulators would be used, and the cost of setting up the line would not vary greatly; nor would the insulation of the wire form an important factor. As the loss in transmission depends chiefly upon the size of wire used (assuming a given distance and power), we can consider the amount of copper required as the variable affecting the cost of the line, depending upon the line loss, and the larger the wire, the less the percentage of loss.

With the cost of the plant and operation, the reverse is true; the greater the loss, the larger the plant and the cost of running it; in any case, there will be a minimum limit for both, which would be reached if the line loss were non-existent, but just as this loss increases, so these two charges will increase. That is to say, if there be 10 per cent. lost in the line, then the power plant will have to be 10 per cent larger than if no loss existed, and the operating cost will be proportionately greater, in some of the items.

As a rule, the excess power will not cost as much in proportion as that which would be needed to satisfy the minimum limit, but it will be considerable. It might not be necessary to enlarge the building to accommodate the extra size of engine and boiler necessitated by the line loss, nor the number of men required to run the plant, but the engines, boilers and generators must be larger, and more fuel would be consumed. This is stated in some detail, that a fair allowance may be made for such "excess" plant, where by "excess" we mean that over and above what would be necessary if there were no line losses.

Let us first consider the cost of copper wire in our lines, using the following notation:

D = Distance of transmission (one way) in feet.
K = Kilowatts to be delivered at distant motor.
l = Percentage of K that is lost in the line.
V = Voltage at distant (motor) end.
W = Pounds of copper in line (including all wires).
c = Cost of copper wire per lb. in dollars.
A, B, = Constants to be selected from tables.

Then the cost of copper in the line for one per cent. loss =

$$L_1 = \frac{D^2KcAB}{1{,}000\ V^2} \qquad (1)$$

and for any loss $L = \frac{L_1}{l} = \frac{D^2KcAB}{1{,}000\ V^2l}$ .... (2)

If r = the rate of interest paid on bonds, etc., for capital expenditure, we have the annual charge for such line for 1 per cent. line loss =

$$La = \frac{D^2KcABr}{100{,}000\ V^2} = \frac{L_1r}{100} \qquad (3)$$

and for any loss, $\frac{La}{l}$ .... (4)

In these formulae A and B should have the following values:

System.	Values of A.	Values of B.				
		Per cent. power factor.				
		100	95	90	85	80
Direct or single-phase alternating.	6.04	2,160	2,400	2,660	3,000	3,380
Two-phase alternating (4 wire).....	12.08	1,080	1,200	1,330	1,500	1,690
Three-phase alternating (3 wire)..	9.06	1,080	1,200	1,330	1,500	1,690

Example: Transmission of 150 k.w. direct current, for 2,000 ft., with 220 volts at the motor, copper wire being 16 2/3 cents per pound, or 6 lbs. for one dollar, and interest rate being 5 per cent.

Then $L_1 = \frac{4{,}000{,}000 \times 150 \times 6.04 \times 2{,}160}{6 \times 1{,}000 \times 48{,}400} = \$26{,}954$, which would be the cost of line for one per cent. drop, and the annual rate on this would be $La = \frac{26{,}954 \times 5}{100} = \$1{,}347$.

These values divided by the loss, give the corresponding cost; thus for 10 per cent. loss, the cost of wires would be $\frac{L_1}{l} = \frac{26{,}954}{10} = \$2{,}695$, as per formula 2, and the interest on same, $\frac{La}{l} = \frac{1{,}347}{10} = \$134$.

We find that the cost of the line will be practically fixed when the distance, power, system and potential are determined (as they naturally will be), except as to the drop, which, therefore, becomes the variable for this expression.

We must secondly discuss the cost of "excess plant" required. To begin with, we must know this amount per kilowatt generated. Dynamos may cost in the neighborhood of \$15 per k.w., but engines and boilers are usually figured by the h.p., and, of course, the type of plant has much to do with this factor. If we estimate engines @ \$15 per h.p., boilers @ \$14 per h.p., pumps and heaters @ \$1 per h.p., piping @ \$5 per h.p., chimney @ \$4 per h.p., housing @ \$11 per h.p., we have a total of \$50 per h.p. If condensers, economizers and mechanical stokers are used, the cost will be greater; if gas engines or other prime movers are used, the estimate must be figured accordingly. As there are 746 watts to an electrical h.p., the cost per k.w. would run about \$65, and with \$15 for generators, a total of \$80 per k.w. But unit prices decrease as the size of machinery increases, so that we should probably assume \$60 per k.w. for the "excess" over the delivered power. For a loss of 1 per cent. (necessitating an increase in power station of 1 per cent.) we should have

$$P_1 = \frac{pK}{100} \qquad (5)$$

Where p = the cost of plant per kilowatt of excess, and for any loss, the excess cost will be

$$P = P_1l = \frac{pKl}{100} \qquad (6)$$

Similarly the annual interest will be on 1 per cent loss.

$$Pa = \frac{pKr}{10{,}000} = \frac{P_1r}{100} \qquad (7)$$

and for any special loss, Pa l .... (8)

Thus for our previous example, the "excess" plant, based on above figures, would stand for 1 per cent. loss (eq. 5)

$P_1 = \frac{60 \times 150}{100} = \$90$, or for 10 per cent. loss, $P_1l = 90 \times 10 = \$900$, and the interest on these amounts, \$4.50 and \$45, respectively.

The third item, cost of operation per year, depends on the plant and the method and hours of operation. Generally the cost of fuel is the heaviest individual expense, but in any case, the cost can be approximately determined per year when the purposes of the installation are known. The charges should, of course, include depreciation and repairs, as well as labor. In a plant recently figured, with very cheap fuel, the amount was \$12 per year per h.p., although in many cases

it might run three or four times that amount. This would make the cost per k.w.-year about \$16. If we let this annual charge be represented by n and the same at one per cent. by Na we have:

$$Na = \frac{nK}{100} \quad \ldots\ldots (9)$$

and the annual charge for any loss will be

$$Nal \quad \ldots\ldots (10)$$

or at \$16 per kilowatt year = n,

$$Na = \frac{16 \times 150}{100} = \$24, \text{ or for 10 per cent. loss}$$

Nal = 24 × 10 = \$240 per year.

We are now ready to combine these data, and it is evident that the total cost per year, including interest on the invested capital =

$$Ta = \frac{La}{l} + Pal + Nal \quad \ldots\ldots (11)$$

Now by calculus, we can obtain the amount of loss "l," which will produce the lowest annual cost, thus:

$$dTa = Padl + Nadl - \frac{La}{l^2} dl$$

$$\frac{dTa}{dl} = Pa + Na - \frac{La}{l^2} = 0 \text{ for a minimum value of l, and, therefore,}$$

$$\frac{La}{l^2} = Pa + Na, \; l^2 = \frac{La}{Pa + Na} \text{ and } l = \sqrt{\frac{La}{Pa + Na}} \quad \ldots\ldots (12)$$

This last equation (12) gives us the minimum cost per year, including operation and interest on investment.

Let us now apply it to our previous figures. In these, La = 1,347, Pa = 4.50, and Na = 24, therefore,

$$l = \sqrt{\frac{1{,}347}{4.5 + 24}} = \sqrt{\frac{1{,}347}{28.5}} = \sqrt{47.3} = 6.88, \text{ or}$$

very nearly 7 per cent. loss. If we substitute this value of l in equation 11, we obtain

$$Ta = \frac{1{,}347}{6.88} + 4.50 \times 6.88 + 24 \times 6.88 = \frac{1{,}347}{6.88} + 28.5 \times 6.88 =$$

196 + 196 = \$392 per year.

Now in this formula (No. 11), the annual cost of wasted energy is Pal + Nal = 28.5 × 6.88 = 196, and the annual interest (no depreciation allowed on the line wires) on the portion of cost which is proportional to the section of the conductors is evidently $\frac{La}{l} = \frac{1{,}347}{6.88}$ = 196, as La is based on the cost of the conducting wires, which evidently is proportional to their sectional area, as shown by formula 3, and as both values are 196, they are equal, and prove Lord Kelvin's proposition. By substituting 5, 7 and 10 for l in equation 11, we can obtain the cost per year at each loss, and from formulae 2 and 6 the cost of the "excess" capital, due to line losses. These are given in the following table:

COMPARATIVE COST.

LINE LOSSES.	5 %	7 %	10 %
Cost of copper in line	\$5,391	\$3,851	\$2,695
Cost of "excess" plant	450	630	900
Total excess and wire	\$5,841	\$4,481	\$3,595
Annual interest on wire	269	193	134
Annual interest on excess plant	23	32	45
Annual operating cost on excess plant	120	168	240
Total annual cost and interest	\$412	\$393	\$419

Our minimum annual cost was \$392 at 6.88 per cent. line loss as found previously, and 7 per cent. is only one dollar greater. The annual costs of operating at 5 and at 10 per cent. loss are very nearly the same—only \$7 difference between them, but there is a difference of nearly \$2,250 in the cost of installation, in favor of the 10 per cent. line loss, and while the interest on the increased cost is included in the operating expenses, it is seldom that the extra outlay would be desirable, unless for purposes of regulation under a variable load.

THE DIFFICULTY WITH THE LARGE SHOP.—A good organization is absolutely necessary to get good results, whether a shop be large or small, but the larger the shop the greater are the opportunities for a poor organization to become conspicuous and wasteful. The larger the shop the more difficult it is to find the right kind of superintendent and foremen to manage it, and the more they can earn for a railroad company, their possibilities are greater in proportion to the amount of work done.—*Mr. M. K. Barnum, before the Western Railway Club.*

WHAT CONSTITUTES AN "ENGINE FAILURE?"

Because of great differences in the definition of what are known as "engine failures" on different roads there is an opportunity for misunderstanding, which may, perhaps, cause a serious reflection upon the motive power department, which is not merited, but is occasioned by the fact that these records are not all kept upon a uniform or standard basis. For example: some roads report as an engine failure anything whatever that delays a train over two minutes on the road, which is chargeable in any way to the locomotive, whether or not such time is subsequently made up. Other roads count only breakdowns, and because of the uncertainty of what an "engine failure" is, it seems advisable to urge the Master Mechanics' Association to take steps for an officially recognized definition.

The Chicago & Northwestern Railway has made the definition of an "engine failure" the subject of an official circular, which has been in effect for several years, and is reproduced below. The object of a general understanding of this subject is to permit of securing accurate information as to delays on the road and the reasons for them. A study of this circular will indicate some of the points which should be covered:

CHICAGO & NORTHWESTERN RAILWAY COMPANY.

DEFINITION OF WHAT CONSTITUTES AN ENGINE FAILURE.

1. All delays waiting for an engine at an initial terminal, except in cases where an engine must be turned and does not arrive in time to be despatched and cared for before leaving time.
2. All delays on account of engines breaking down, running hot, not steaming well, or having to reduce tonnage on account of defective engine, making a delay at a terminal, a meeting point, a junction connection, or delaying other traffic.

DELAYS THAT SHOULD NOT BE CONSIDERED AN ENGINE FAILURE.

1. Do not report cases where engines lose time and afterwards regain it without delay to connections or other traffic.
2. In cases where a passenger or scheduled freight train is delayed from other causes, and an engine (having a defect) makes up more time than it loses on its own account, should not be called an engine failure.
3. Do not report delays to passenger trains when they are less than five minutes late at terminals or junction points.
4. Do not report delays to scheduled freight trains when they are less than twenty minutes late at terminals or junction points.
5. Do not report delays when an engine is given excess of tonnage and stalls on a hill, providing the engine is working and steaming well.
6. Do not report delays on extra dead freight trains if the run is made in less hours than the miles divided by ten.
7. Do not report engine failures on account of engines steaming poorly, or flues leaking, on any run where the engine has been delayed on sidetracks other than by defects of engine, or on the road an unreasonable length of time: say fifteen hours or more per 100 miles.
8. Do not report an engine failure for reasonable delays in cleaning fires and ash pans on the road.
9. Do not report failures against engines that are coming from outside points to the shops for repairs.
10. Do not report cases where an engine is held in the roundhouse for needed repairs, and called for by the operating department, they being informed that the engine will not be ready until a stated time. Failure to provide that engine before that stated time should not be called an engine failure.
11. Do not report broken draft rigging on engines and tenders caused by air being set on train, account of bursting hose or breaking in two.
12. Do not report delays to fast schedule trains when the weather conditions are such that it is impossible to make the

time, providing the engine is working and steaming well.

13. Do not report delays when an engine gets out of coal and water, caused by being held between coal and water stations an unreasonable length of time.

EMPLOYEES ON AMERICAN RAILROADS.

The number of persons on the payrolls of the railways in the United States, as returned to the Interstate Commerce Commission for June 30, 1904, was 1,296,121, or 611 per 100 miles of line. These figures, when compared with corresponding ones for the year 1903, show a decrease of 16,416 in the number of employees, or 28 per 100 miles of line. The classification of employees includes enginemen, 52,451; firemen, 55,004; conductors, 39,645, and other trainmen, 106,734. There were 46,262 switch tenders, crossing tenders and watchmen. With regard to the four general divisions of railway employment, it appears that general administration required the services of 48,746 employees; maintenance of way and structures, 415,721 employees; maintenance of equipment, 261,819 employees, and conducting transportation, 566,798 employees. This statement disregards a few employees of which no assignment was made.

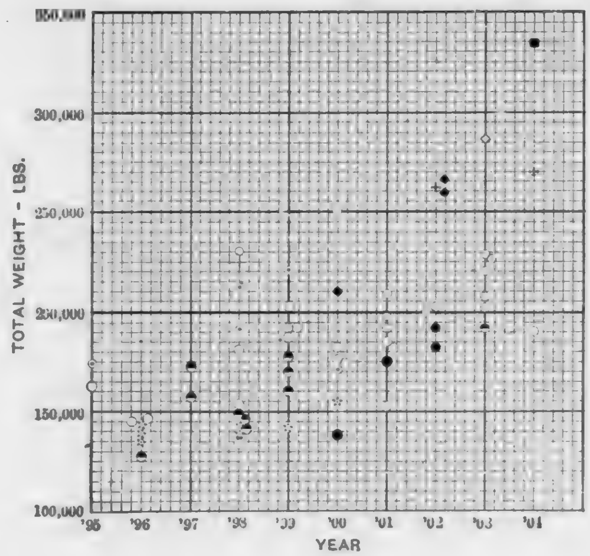
The usual statement of the average daily compensation of the 18 classes of employees for a series of years is continued in the present report, which shows also the aggregate amount of compensation paid to more than 99 per cent. of the number of employees for the year 1904, 97 per cent. for the year 1903, and more than 99 per cent. for the five years preceding. The amount of wages and salaries paid to employees during the year ending June 30, 1904, as reported, was $817,598,810.

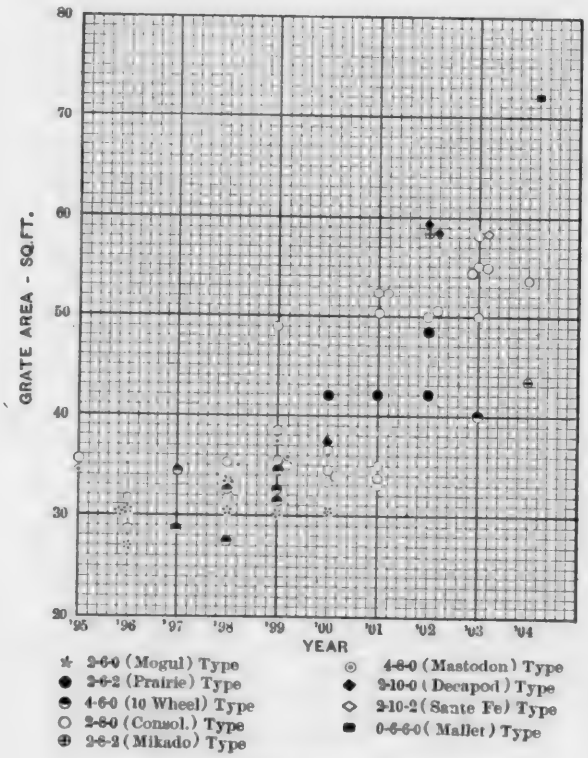
LOCOMOTIVE PROGRESS.

The demands on both passenger and freight locomotives have increased very greatly during the past decade and have necessitated a corresponding increase in the size and capacity of the locomotives, which has made necessary some radical changes in their design and construction. As the service has become more severe certain types have reached their limitations and this period is remarkable for the number of new types which have been introduced, some of which have been developed to a considerable extent. The accompanying diagrams show graphically the progress which has been made with the various types of both freight and passenger, bituminous coal burning locomotives with respect to their total weight, weight on drivers, tractive power, heating surface and grate area, since 1895. This journal makes a practice of describing the most notable locomotives which are built from time to time and the data for the 62 passenger engines and the 65 freight engines, considered in the diagrams, is for bituminous coal burning locomotives which have been described in it. Each type is represented by a different symbol so that the progress made with the individual types may be traced.

PASSENGER LOCOMOTIVES.

The increase in the total weight and heating surface has been steady and uniform, the 8-wheel and 10-wheel types being succeeded by the Atlantic, Prairie and Pacific types. The increase in the weight on drivers and the tractive power, however, is not so marked. In the case of the Atlantic type the weight on drivers has gradually increased since its introduction and the same is true in a lesser degree of the tractive power. The tractive power of a few of the 10-wheel engines is quite high, but this is due to some extent to the small diameter of the driving wheels, which of course unfits them for the high speed work of the Prairie and Pacific types, which to a great extent superseded the 10-wheel type in passenger service. A comparison of the heating surface and grate area diagrams with that for the tractive power shows that they have increased at a faster rate than the tractive power, thus indicating that the more recent designs have a greater steaming capacity and are better fitted for sustained high speed. The advent of the wide firebox and its general adoption is indicated by the abrupt increase in the size of grate area beginning about 1901.

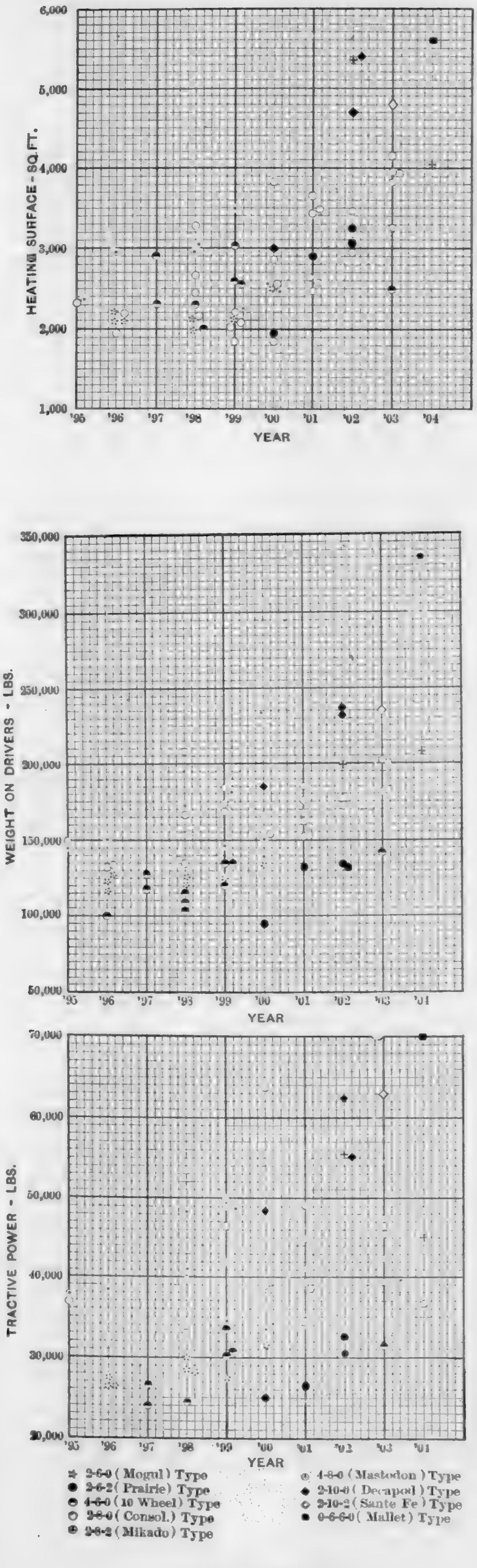




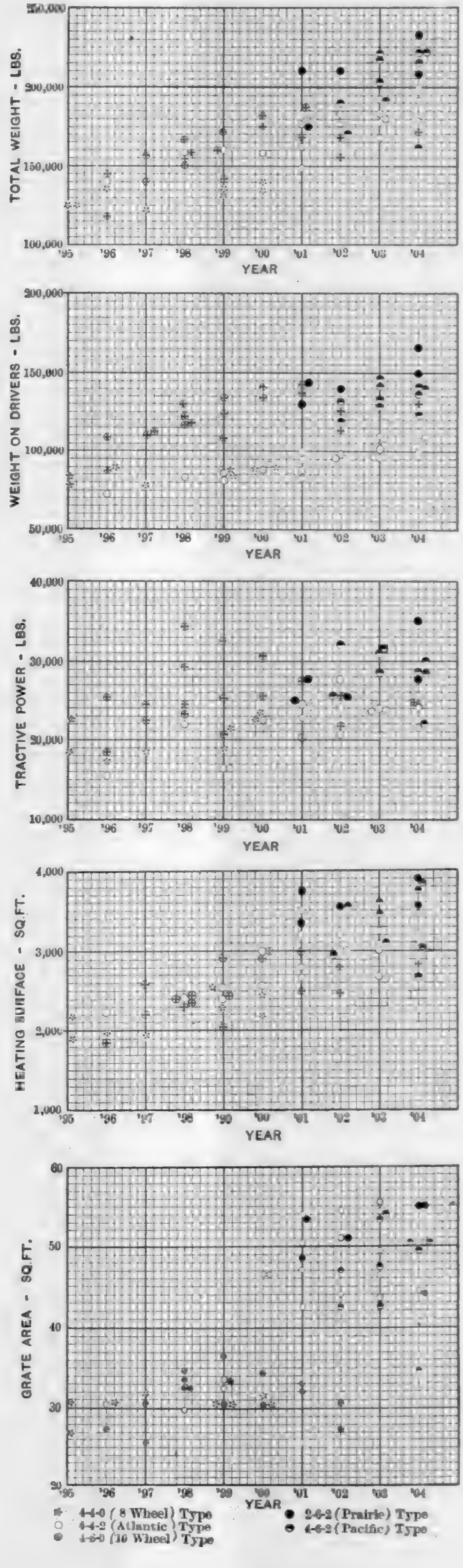
FREIGHT ENGINES.

FREIGHT LOCOMOTIVES.

It will be found that as a rule the heavier and more powerful locomotives for each year were used on roads with very heavy grades, and the rapid increase in the total weight, weight on drivers, tractive power and heating surface of this class of locomotives is remarkable. This class includes the Mastodon type for the first two or three years shown; the two very heavy consolidation engines and Mikado, Decapod, Santa Fe and Mallet types. The lighter and less powerful freight locomotives used in ordinary service have also developed steadily in these respects. This may be seen by tracing the progress of the consolidation type. There is still a lighter class of freight locomotives, comprising some of the 10-wheel and the Prairie type, which is used for fast freight service, and the development of this class may also be traced on the diagrams. The abrupt increase in the grate area, which took place in 1900 and 1901, indicates the introduction and adoption of the wide firebox.



FREIGHT ENGINES.



PASSENGER ENGINES.

DESIGN OF STEEL CARS WITH REFERENCE TO REPAIRS.

BY A. STUCKI.

Simplicity in the design of cars is a fundamental principle, which at no time should be lost sight of, and generally speaking, if a construction is of a simple nature, i.e., if all complex arrangements of details are successfully avoided, we may look for a long life of the car with a comparatively small amount of repairs. There are limits, however, where simplicity, if carried to an extreme, will interfere with the ease of repair. For instance, details exposed to constant wear and tear are expected to last only a certain time, after which they are renewed. There are also members which are entirely free from wear, and if well designed never require any further consideration. Combining details of these two types into one piece would certainly be wrong in principle, although the design of the car would have been simplified.

Again, some details are exposed to severe strains, blows and shocks, while others, although near by, are exempt, and combining these two classes of details into one piece is again wrong in principle, inasmuch as the whole would either have to be made heavy throughout to meet the localized heavy strains, or else premature failure would be sure to follow. (By this I have principally reference to rolled sections and plates and not to castings, as the latter can be strengthened in those parts mostly exposed, so that the casting as a whole may be made of a uniform degree of safety.)

A good example of what has just been said is represented by the centre sills of the car. Between the body bolster and the end sill, they are subjected to the maximum blow coming on the car, while between the body blosters this strain is more or less distributed. For this reason the portion between the body bolsters and the end sills, the draft sills, has often been made separate from the main centre sills, and, thus, it is possible to renew the member, which is bound to give first, very easily and without disturbing the main sills. It is good practice to extend the main sills through the body bolster and to unite the two by a sufficient number of rivets, but above all care should be taken that the portion of the main sills between the joint and the body bolster is braced or otherwise strengthened, so as to exclude the possibility of a failure at that point.

Often ease of repairs is coincident with ease of original construction. For instance, side and floor plates of gondola and hopper cars, if made in convenient sections, will greatly facilitate the building of the cars. The material is much more quickly handled, much more rapidly punched, and more easily assembled. In many cases the output of the shop is greatly reduced on account of being compelled to handle long and narrow centre floor sheets, extending from one end of the car to the other. Rack and multiple punches will, of course, overcome the trouble in punching, but the loss of time in handling and assembling remains. Naturally care must be exercised so as not to impair the strength of the car in the endeavor to facilitate the construction. This is especially true with reference to the car sides, but they are easily strengthened by proper splices at the joints of the sheets and by continuous top and bottom members. Such an arrangement of small sheets will come in very handy in the repair of the cars. If, for instance, the side of a car near its centre is damaged it will only be necessary to remove the damaged section, leaving the balance of the car intact, with the additional advantage of having the repaired car of exactly the same construction as it originally was, doing away with the patchy appearance often met with on repaired cars.

It is also very essential that each detail and each subconstruction be connected to the whole car in such a way, that it may be removed, whenever necessary, without disturbing the adjoining details. It is not sufficient to design, so that all these details can easily be erected in the car shop. We must go one step further and see that these details do not interlock with each other, so that any detail, no matter whether it was applied first or last, may be removed with the same ease, whenever it becomes disabled in service. For this reason it seems wrong in principle to project some members of the body bolster through the center sills. This plan excludes the possibility of removing a center sill without actually taking the whole car apart, and, also, greatly complicates the matter of repairs to the body bolster itself.

Sometimes it is advisable to use one detail for fastening several other members. For instance, a corner bracket may serve as a support for the diagonal braces, a tie between the end and side sills, a backing for the push pole casting, and a fastening for the corner post, and it is evident that if this bracket should have to be renewed, all the other four members would likewise have to be disconnected, while, on the other hand, any one of these four members, if disabled, could be repaired or renewed without affecting all the other members, and it is clear that the bracket should be made stronger than the other component details, so as to reduce the liability of breaking. Many similar cases could be pointed out on the average car, and therefore the principle of making such combination details stronger than the adjoining members is that much more important.

As a rule, every rivet in the whole car should be accessible, even after the car is completed, and no design should be approved if there is not provision made for driving every rivet properly. In a pinch, the rivets have sometimes to be bent before they can be inserted; this should be avoided, if at all possible. Likewise countersunk rivets should be avoided, especially if they are covered over with other details, because it may become necessary to renew the piece fastened by the countersunk rivets, which would also mean a removal of the covering detail. There are exceptional cases where it is not likely that rivets ever will have to be disturbed, and therefore can be covered up by other details without hesitation. This mostly refers to flange angle rivets of the centre sills, which are often covered up with the hopper sheets. These rivets will not have to be disturbed unless the sills are damaged, and it is hardly possible that an accident could do this without also damaging the covering sheets, so that the above rule would not necessarily apply to these rivets.

The increasing competition in car building makes special machinery indispensible. Such machines not only save a great deal of labor and improve the accuracy and the finish of the work, but they also will turn out all details alike and interchangeable, which in itself is of great advantage. This holds true with the gang, rack and multiple punches, gang drill presses, pneumatic chipping tools, reamers and riveters, pit riveters, combined punches and riveters, bulldozers and presses, provided simple shapes are adhered to. But to be also beneficial in the repair of the cars, the work turned out by these special machines should be such that it can at any time be duplicated by hand. Often two or more simple pieces are made with one stroke in a special die. This is true economy and does not make repair difficult, as each single piece can, if necessary, be duplicated by hand. However, pressed pieces of intricate shape made on special dies will naturally be detrimental in this respect, unless each railroad keeps a certain number of these pieces in stock.

Speaking of stock material, it is of the utmost importance that the designer limit himself to as few sizes as possible. This refers principally to rolled shapes, and if this principle is carried out on all the different types of cars, a railroad can take care of all possible repair without carrying an unreasonably large amount of material. The same principle holds good in regard to castings, and if similar constructions for the different types of cars are adhered to, the same patterns can often be used over and over again. Great care should be taken so as not to make the castings of two opposite hands, if not absolutely necessary, and very often this can be avoided by an additional hole or other similar slight modification. It is true these additions are only used in half the cases, but the fact that half of the pattern work is saved thereby and that the

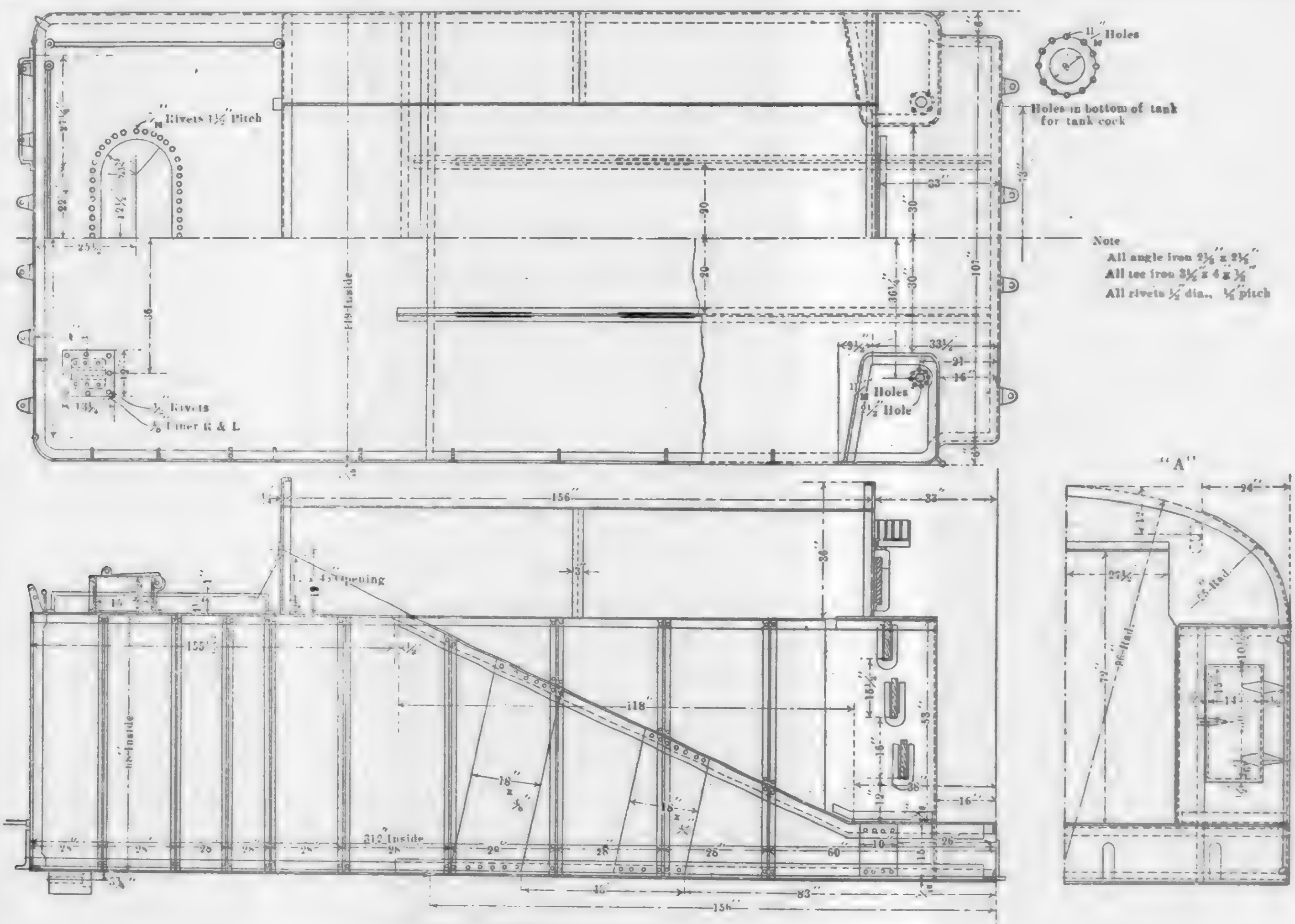
amount of stock castings is reduced will fully repay for such precautions.

To sum up, the following points should be carefully watched in order to facilitate the repair of steel cars:

1. Parts having wearing surfaces should be made removable.
2. Parts most likely to be damaged should be made removable.
3. Unwieldy large plates should be cut into smaller pieces, if consistent with the strength of the car.
4. Details should not interlock, but should be removable without disturbing the adjoining parts.
5. Combination details should be stronger than the parts fastened to them.
6. All rivets should be accessible after the car is finished.
7. The work done by the special machines should be of such a nature that it can be duplicated by hand, if necessary.
8. The number of patterns and the number of stock sizes in the rolled shapes should be kept as low as possible.

zontal distance of 24 ins. inside of the outer vertical face of the tank. At the front and back diaphragms connect these side hoods, permitting the coal to be carried high without the slightest danger of its falling out. These tanks have a water bottom under the firemen's feet, to which all the coal in the coal space is brought by gravity. This design also includes a coal gate of four planks 10 ins. wide, fitted in sockets, as noted in the drawing. When not in use these are carried in other sockets, keeping them up out of the way. Reports of the service of these tenders indicate that they are very satisfactory. This design has been used on a large number of locomotives, and the loss of coal from tenders while on the road is entirely eliminated.

WRITING ON BLUEPRINTS.—A solution of carbonate of soda or caustic soda, frequently recommended for the purpose, is not nearly so good as one of potassium oxalate. The uniform strength of solution is important, though why a variation in the strength of such a neutral substance as potassium oxalate should make any difference I am unable to say. However, 75 grains dissolved in an ounce of water will remove the blue ground of the drawing in a few seconds; it can be applied with a pen or fine brush, the solution, if necessary, being thickened with gum. The paper should be well washed afterward, for if this is not done the blue color is very likely to reappear. Engineers who use this method on large tracings frequently content themselves with mopping off the surplus solution with blotting paper and "washing" the treated part by applying wet blotting paper once or twice. This imperfect method of removing the chemicals is, no doubt, responsible for the complaint made in many engineering shops that details written in this way gradually disappear from the drawing, the blue ground being gradually restored.—*Photo-American.*



TENDER TANK, 8,000 GALLONS CAPACITY—C. B. & Q. RAILWAY.

TENDER—8,000 GALLONS CAPACITY.

CHICAGO, BURLINGTON & QUINCY RAILWAY.

The class R-4 Pacific type locomotive of the Chicago, Burlington & Quincy was illustrated in this journal in September, 1904. The photograph which appeared at that time showed the exterior of the tender, which has a capacity of 8,000 gals. of water and 16 tons of coal. The longitudinal section of the tank shows the method of bracing, the slope of the inclined floor of the coal space and the arrangement of hoods carried up at the sides of the coal space to prevent the coal from falling off. The drawings show the form of these hood plates, which terminate at points "A" at a hori-

(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE.

J. S. BONSALL,
Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT,
E. A. AVERILL, } **Editors.**

JANUARY, 1906.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union. Remit by Express Money Order, Draft or Post Office Order. Subscription for this paper will be received and copies kept for sale by the*
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Damrell & Upham, 283 Washington St., Boston, Mass.
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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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As we go to press the indications are that there will be a general strike of the compositors of New York City after January 1st. We do not expect that this will interfere with the publication of our journal; but, if so, would ask our readers and advertisers to overlook any delay or shortcomings which may result from this cause.

It gives us pleasure to announce that Mr. E. A. Averill has become associated with our editorial department. He was graduated from the mechanical engineering department of Cornell University in 1900, specializing in railroad work in his senior year. The summer of 1899 he spent in the Reading shops of the Philadelphia & Reading, and in September, 1900, he entered the service of the Chicago, Burlington & Quincy as special apprentice, and spent three and a half years in this capacity at LaCrosse, Aurora and Chicago. Since April, 1904, he has been associate editor of the Railway and Engineering Review, at Chicago.

"Piecework inspector" is usually the title of the man who exercises the important function of introducing and establishing piecework in railroad shops. This is an unfortunate name; why not call him something else? It is not considered quite the thing to appoint a policeman to greet one's friends at a reception, although it is perhaps well to have one at hand, but in the background. Much depends upon who the friends are. Would it not be better to place piecework in charge of a man whose chief qualification is his knowledge of the work to be done, and whose chief duty is to use this knowledge in every possible way to help the workmen to realize the benefits of piecework? The opinion of a newspaper may not be very valuable in this matter, but it can do no harm to observe that many people do not start piecework upon the foundation of a study of human nature. When piecework is once started on a correct basis of prices the next thing to be done is to show the men how they can make the highest wages. "Inspectors" cannot do this.

Not to know what you are buying is sometimes excusable, but not to know what you are selling is unpardonable. A shop superintendent in charge of one of the largest and most up-to-date railroad shops told the writer that he recently needed a machine for making a certain part of which large numbers were used. In consultation with the machine tool manufacturers looking to the purchase of a machine which would turn them out at the minimum expense, he was urged to buy a certain machine because the manufacturers guaranteed it to make 75 of the pieces in ten hours. This being the best guarantee offered, the machine was installed. The manufacturer had put on his best man to make the 75 pieces and expected to be asked to loan the man to show the railroad shop people how to get the maximum output from the machine. In fact, the offer of the man was made to the purchaser. When the machine was put into service the job was turned over to a bright young man in the railroad shop, who was not told how much work was expected of him. He turned out 250 pieces the first day.

In visiting the mechanical department of one of the leading American railroads the Editor had occasion to consult the back numbers of this journal for 1903, and the mechanical engineer sent a boy for the file. He returned, bringing ten of the worst-looking papers possible to imagine. They were thumbed and soiled, and were practically worn-out, but by legitimate use and not abuse. The ten numbers, containing articles on the Collinwood shops, showed this hard service, and on inquiring the reason it was found that every plan and detail of these shops had been carefully studied and considered in connection with new plans of the shop plant, which the road in question has worked up. This is significant of the importance of shop installations, and such a study of existing construction means much for the railroads. It is beginning to be appreciated that railroad shops, which are to stand for perhaps thirty or forty years as a monument of the intelligence of the designers, must involve an expenditure of from one to two million dollars. This constitutes a problem to be considered seriously. It is easy to recall days when shops were built without much study or consultation with anybody, and the difference in facilities and efficiency of the two methods are now everywhere recognized.

It seems fair to assume that in the process of handling locomotive boiler flues in the shop, considering the same steps through which the flues must pass after their removal from the boiler and up to their return to the boiler again, the cost of the work should be fairly uniform all over the country. As the cost of labor varies in different sections, of course, the expense of this work will vary somewhat, but the actual variation in prices paid for this work in the various shops of one road and in the shops of different roads is out of all proportion to the varying prices for labor. While flue work does not involve a great expense proportionately to the total cost of locomotive repairs it is one of the steady expenses which mounts up year by year. In a casual examination of figures received from a number of roads prices of 3.5, 3.75, 3.45, 3.82 cents have been noted. A number of other shops do this work at a cost of 4 cents. These figures include transportation of the flues, cleaning, cutting off the safe ends, scarfing, attaching, welding and testing. In many other shops the figures run very much higher. As this work, handled in the best possible manner, does not involve expensive machinery those whose prices run much higher than these will find it worth while to look into the subject with a view of securing the best possible furnaces, the best arrangement of the furnaces and machinery, and the provision of inclined

planes, or horses, or perhaps racks in order to cut down the expense to the proper figure. It is an interesting fact that the shop which has the best arrangement for handling flues is very often likely to be well managed in other respects, because good shop management is very conspicuous and the lack of it equally conspicuous in the flue work where deficiencies cannot be hidden. For this reason shop superintendents may profitably give this department considerable thought.

HEAVY PASSENGER CARS.

The matter of the weights of passenger cars is emphasized by the recent acceleration of long-distance trains between New York and Chicago. It may be necessary to build for this service the very heavy cars of the present time with trucks weighing as much as the whole car ought to weigh, but it certainly seems reasonable to believe that the weights may be materially reduced by the use of steel construction in the framing of such equipment. No one can tell what the future is to bring forth in the way of the development of the locomotive, but there is reason to believe that weights on individual driving wheels have reached the safe limit of the present rails. Whatever the balanced compound may accomplish in the matter of reducing the variation of pressure between the wheels and the rail, the static weights themselves have reached a point beyond which it seems to be unwise to proceed. This limit once reached does not mean that finality in locomotive development has been attained, and consolidation or even decapod locomotives may yet be used to haul passenger trains. This seems on its face to be an absurd suggestion, but it is not as absurd as it seems, when passenger trains on a large number of roads have reached the weight of 600 tons in ordinary service. There will undoubtedly be great opposition against the lightening of cars, but, nevertheless, this is the direction in which the railroads will be forced to go in order to find the relief which is becoming necessary. This relief may perhaps not be as difficult as it seems at the present time, because as yet practically nothing has been done towards the introduction of steel construction into long-distance passenger equipment.

On the whole, it seems strange that more progress has not been made in such a promising field, and there seems to be no question that this is not only probable, but a necessary direction for the efforts of the designers to-day. The American traveler will not be deprived of his comforts and luxuries. Five thousand, one hundred and eighty pounds per passenger is a very expensive proportion from the standpoint of the railroads. The car designer has an attractive problem, though a difficult one, in designing his car, with the luxuries as a basis, and making the structure of metal and lighter than the structures of present practice.

MILD EXHAUST.

A high official of an American railroad who has just returned from abroad was particularly impressed with the very mild exhaust of foreign locomotives, particularly in France, and inquired the reason.

The soft exhaust of French locomotives is noteworthy. Without doubt much is due to the use of variable exhaust nozzles and the absence of diaphragm plates in the smokeboxes. The methods employed by French and English railways permit of giving to each class of new locomotive as it is introduced upon the road most careful attention as to the adjustment of the front end appliances. New designs of locomotives are not introduced so frequently as to become the common affair which it has become in this country. Each new design receives the personal attention of the motive power official in such a way that the first example of the new class is made perfect as to the adjustment of its front ends before others are built. Such methods enable foreign locomotive men to avoid the use of the diaphragm plate, which Dr. Goss showed in the AMERICAN ENGINEER tests to be responsible for one-third of the work of the exhaust jet. Variable exhaust nozzles have been repeatedly tried in American practice, but this device has never become a part of our common practice. The principle reason for this is the difficulty in training American engineers to use such a device properly. They do not even use the starting valve of compounds properly, for one need not go very far to find compound starting valves left open during an entire run.

It is different in France where the locomotive engineers are working under a system of premiums, which involve questions of fuel consumption, of punctuality and of otherwise satisfactory service. French locomotive engineers are safely trusted with variable exhaust devices, and they use them and use them properly. In starting out from a station the nozzle is enlarged to save tearing the fire and on the run the nozzle is adjusted to suit the conditions. In case the steam pressure runs down it may usually be quickly restored with the nozzle, but if the nozzle is thus restricted it is done so with care because of its effect upon the earnings of the men at the end of the month, through the consumption of more coal. There is a long history back of the good work of the French locomotive engineers, and one which would make a profitable study for those who appreciate the soft exhaust of their locomotives.

THREE YOUNG COLLEGE MEN.

A short time ago, within three days, three young men of fine appearance called on the editor of this journal to tell about their troubles, which led them to leave railroad service. They came at different times, from different parts of the country, and related widely different experiences.

All had been special apprentices, they had been in the service five, six and nine years, respectively, and all three had risen to the position of roundhouse foreman. The first had received ninety, the second one hundred, and the third one hundred and forty dollars a month, indicating that they were able young men, performing acceptable service.

Each had voluntarily "quit," to accept apparently more promising positions, and this strange coincidence of three promising, fine young men becoming switched from a career which they had followed faithfully for an important period of time, should set railroad officials thinking.

All these young men told the same story, that of no opportunity and of a long line of superiors in excellent health.

The young men were attracted elsewhere by more money and less "grief," for if there is any position to more sorely try men's souls than that of presiding over a roundhouse it has not yet been named. This experience entitles the railroads and also the young men to a word of advice. If a roundhouse is successfully managed by any one, old or young, there is scarcely an administrative task about a railroad too great for that man to solve. If a young man has handled a roundhouse properly, the officials of the railroad who are responsible for letting him escape should be called to account by the owners.

Any technical school graduate, or, for that matter, any undergraduate of the school of hard knocks, who has attained to the successful management of a roundhouse, is foolish to leave it for any outside position, no matter how immediately attractive, for the successful roundhouse foreman has all the elements required of a general manager, and if he sticks to his task nothing can hold him back, not even the longest line of healthy superiors.

The young men perhaps need more patience. Their reward is certain. The railroads need to lose a great many more good men in order to understand the serious consequences of their neglect of the underlying principles of organization. Transportation interests are so great as to be sure to make this matter right some day.

WALSCHAERT VALVE GEAR.*

BY MR. CARL J. MELLIN.

GENERAL DESCRIPTION.

The motion of the valve is derived both from the crosshead and the eccentric crank, from a driving axle. The crosshead connection imparts the lap and lead at the extremities of the stroke, when the eccentric crank is in its middle position. The eccentric crank in this position imparts its fastest movement to the valve to give a very quick opening. The crosshead motion in advancing from the dead point effects an approximate uniformity in the combined motion given to the valve as if it was derived from a single crank or eccentric set with an angle of advance corresponding to the lap and lead. The valve motion may therefore be graphically illustrated in the same manner as that of the Stephenson motion, with a circle representing the path of the eccentric, the diameter of which is equal to the travel of the valve, and the valve events may be determined in the same way by any of the well-known methods of Professor Zeuner and others, as illustrated. It will be observed that the only apparent variation due to this gear is that brought about by the invariable lead.

The Walschaert motion, as usually constructed, does not lend itself as freely to adjustment as does the Stephenson motion with independent eccentrics, and for this reason it is not as liable to get out of adjustment. It must be correctly laid out in the design and correctly fitted up. The importance of this cannot be overestimated. The various points must be carefully plotted in order to give the best results in the combination movement of the parts of the motion. The movements of the motion involve such complications in plotting as to render the complete plotting of all too laborious for every new design, and for this reason the use of an adjustable model is very desirable in designing this gear. However, with complete knowledge of the nature of the gear, simple methods and formulæ may be used to determine the locations of the various points covering the motion. One object of this description is to avoid the necessity of a model except to verify the results.

To entirely overcome the irregularities inherent in all motions transformed from circular into lineal, cannot for practical reasons be expected, but the errors may be reduced to such an extent that they do not affect either the power or economy of the locomotive. This remark is made to forestall the inference that the accuracy of the Walschaert motion as to the cut-off points is not superior to the Stephenson motion when the latter is turned out of the shop.

In the construction of the Walschaert gear the desired travel of the valve, the lead and the maximum cut-off which determines the lap of the valve, are selected. The stroke of the piston being given, the combination lever is proportioned so that a motion equal to the lap and lead is given to the valve when the crosshead is moved from one end of the stroke to the other. The link may be made of any approved design, and is so located that the radius bar will have a length of at least eight times (ten or twelve times is better) the travel of the link block, and the radius of the link should be equal to the length of the radius bar.

For outside admission valves the radius bar is attached to the combination lever between the valve stem and the crosshead connections, and for inside admission (piston valves) it is attached above the valve stem. The fulcrum of the link should lie as nearly as practicable upon a line drawn through the union of the radius bar and combination lever, parallel with the center line of the valve stem. The suspension point of the lifter should have a locus which causes the link block to travel as nearly as practicable on a chord of the arc described by any point of the link wherever the block happens to be when the link is swung into one of its extreme positions. This is most closely approached by a lifter through which the radius bar slides, and does not swing with the link. A properly suspended hanger will accomplish practically the same result, though the slip of the link bar will be somewhat more in the back than in the forward motion, but as the suspension point cannot be made to follow the theoretical locus, it should be made to do so as nearly as possible by favoring the position of the most commonly used cut-offs. In locating the longitudinal position of the link fulcrum, consideration should also be given to the length of the eccentric rod, which should have a minimum length of three and one-half times the eccentric throw, and should be made as long as circumstances will permit, with an approximately equal length of the radius and eccentric rods. The point of connection between the eccentric rod and the link should be as near the center line of motion of the main rod as this correction for rod angularities will permit, but this is often accompanied with the requirement of excessive eccentric throw. In such cases a compromise must be made to raise this point. The fore and aft position of this point relative to the tangent of the link arc must also be determined with reference to the angularity of the eccentric and main rods, so that the link is exactly in its central position when the piston is at either end of the stroke. The angles through which the link swings on both sides of its central position should be as nearly as practicable equal, but this is subordinate to other conditions. Attention should be paid to the effect of the angularity of the main connecting rod upon the cut-off, to reduce this to a minimum, this having an effect upon determining the locus of the suspension point of the lifting link as well as that of the eccentric rod connection to the link.

It is evident that a proper design of Walschaert gear can only be laid out by a skilled draughtsman. In maintenance care is required that all parts should preserve their original forms and positions, and this should be checked by verifying the valve events through turning the main driving wheels before the locomotive goes into service.

The chief point of difference between the Walschaert and Stephenson motions is that the former gives to the valve a constant lead at all cut-offs, whereas the latter produces an increase of lead which becomes excessive at short cut-offs,

METHOD OF ADJUSTING VALVES WITH WALSCHAERT GEAR.

The lap and lead are determined by the proportion of the arms of the combination lever and the stroke of the piston. The amount is found by turning the engine from one dead center to the other center in any cut-off position.

1. The motion must be adjusted with the cranks on the dead centers by lengthening or shortening the eccentric rods until the link takes such a position as to impart no motion to the valve when the link block is moved from its extreme forward to its extreme backward position. Before this change in the eccentric rod is resorted to, the length of the valve stem should be examined, as it may be of advantage to plane off, or line under, the foot of the link support which might correct the lengths of both rods, or at least only one of these should need to be changed.

2. The difference between the two posistions of the valve on the forward and back centers is the lap and lead doubled and cannot be changed except by changing the leverage relations of the combination lever.

3. A given lead determines the lap, or a given lap determines the lead, and it must be divided for both ends as desired by lengthening or shortening the valve spindle.

4. Within certain limits this adjustment may be made by shortening or lengthening the radius bar, but it is desirable to keep the length of this bar equal to the radius of the links, in order to meet the requirements of the first condition.

5. The lead may be increased by reducing the lap, and the cut-off point will then be slightly advanced. Increasing the lap introduces the opposite effect on the cut-off. With good judgment these quantities may be varied to offset their irregularities inherent in transforming rotary into lineal motions.

*From an American Locomotive Company pamphlet.

6. Slight variations may be made in the cut-off points as covered by the previous paragraph, but an independent adjustment cannot be made except by shifting the location of the suspension point, which is preferably determined by a model.

METHOD OF LAYING OUT WALSCHAERT GEAR.

Having presented a general outline of the gear, we may proceed in determining the more important points necessary to obtain a successful motion of the valve, and, as previously stated, the stroke of the engine is given, and the travel and lap and lead of the valve are selected to suit a desired cut-off. We have first to find the proportions of the combination lever. By designating the lap and lead with the letter c, the crank radius with R, the crosshead end of the combination lever with L, and the valve end of same with V, we have $R : c = L : V$ or $V = \frac{cL}{R}$, with the connection F of the radius bar as a fulcrum. The length of the combination lever must be determined from the height of the valve stem over the piston

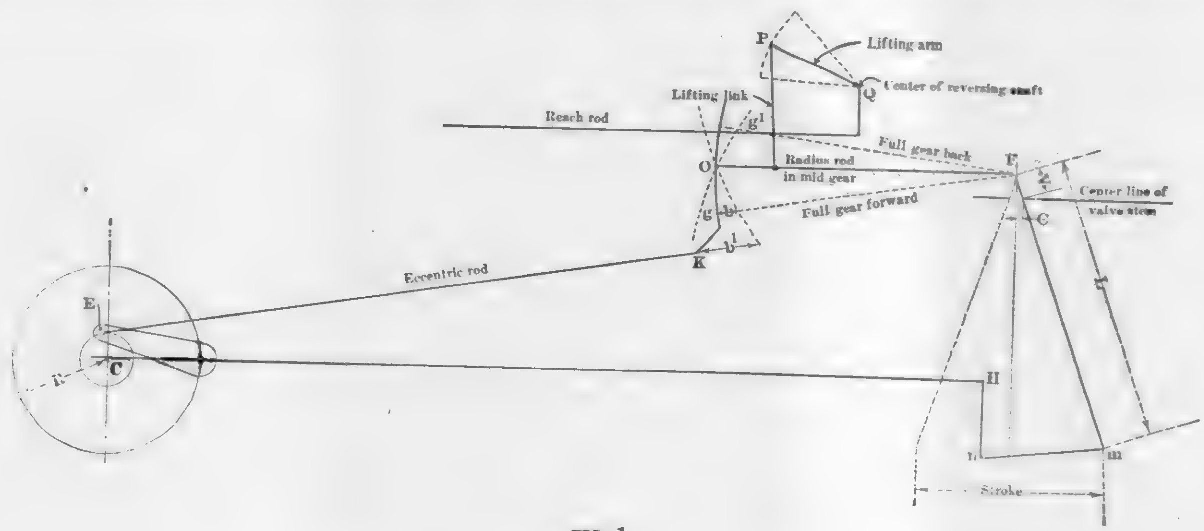


FIG. 1.

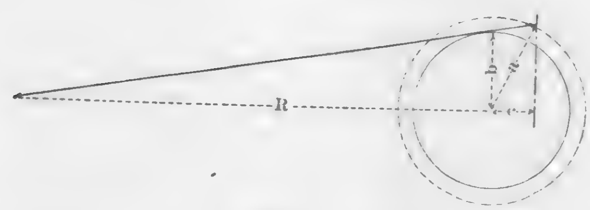


FIG. 2.

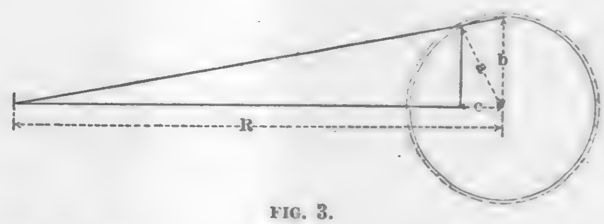


FIG. 3.

rod and a convenient angle of oscillation of forty-five to fifty, which should not exceed sixty, degrees.

We have next to find the required travel of point F, Fig. 1, to obtain the desired valve travel which we, for convenience sake, take on one side of the center position, or half its total travel in full gear, and which we will designate b, when we have

$$b = \frac{R\sqrt{a^2 - c^2}}{R + c} \text{ for outside admission, and}$$

$$b = \frac{R\sqrt{a^2 - c^2}}{R - c} \text{ for inside admission valves,}$$

where a is the radius of an eccentric that would give the required travel of the valve, and c is as given above.

This may be laid out graphically as in Figs. 2 and 3, when a is equal to one-half the travel of the valve and R and c the same as in the above formulæ.

With the limited amount it is advisable to allow in raising and lowering the link block in reversing the motion, we can without practical error consider the half movement of the link block g to be the same as that of point F, and by limiting the angle of the swing of the link to a maximum of forty-five degress, we get the raise or depression of the radius bar and link block $O\,g = \frac{b}{\tan. d}$, where O is the link fulcrum and d = half the angle of swing of the link.

The location of the link and eccentric rod connecting point K cannot be determined with any practicable formula, but must, as already stated, be found by plotting to meet the requirements of the different cut-offs and corresponding crank positions. The same is also the case with determining the locus for the suspension point P of the lifting link, and in these two locations lies the principal success of the gear.

REULEAUX AND ZEUNER DIAGRAMS.

Figure 4 shows a combination of two diagrams; namely, those of Reuleaux and Zeuner, which coincide exactly as to the different valve events, which may be found as follows:

The distance AB represents the travel of the valve as well as the stroke of the engine, though in different scales, which makes no difference when the cut-off is always expressed in fractions or per cent. of AB. The maximum cut-off is determined upon to be AR. Draw a perpendicular line RC from AB until it cuts the arc ACB. Next decide on a desired lead and, with that as a radius, draw an arc with A as a center. Draw a line from C tangent to the lead circle around A, when the lap of the valve is found to be equal to the perpendicular distance from the line CS to the center O of the diagram. The crank will then be in position OS when the valve commences to open or the angle AOS in advance of the dead center and on OC at cut-off. Continuing, we find the valve in its middle position when the crank, is on OG which is drawn parallel to SC through the center O. Extend this line to F, and with the exhaust lap as a radius draw the exhaust lap circle on the opposite side of the line GF and draw DE tangent to this circle, when OD is the position of the crank at the release point. From this point the exhaust remains open until the crank reaches the position OE, when it closes and compression takes place until it again reaches OS for admission and one revolution is completed.

By placing the Zeuner diagram upon this, draw HJ perpendicular to FG, and with the radius OH of the eccentric circle as a diameter, draw the admission valve circle OVHnO

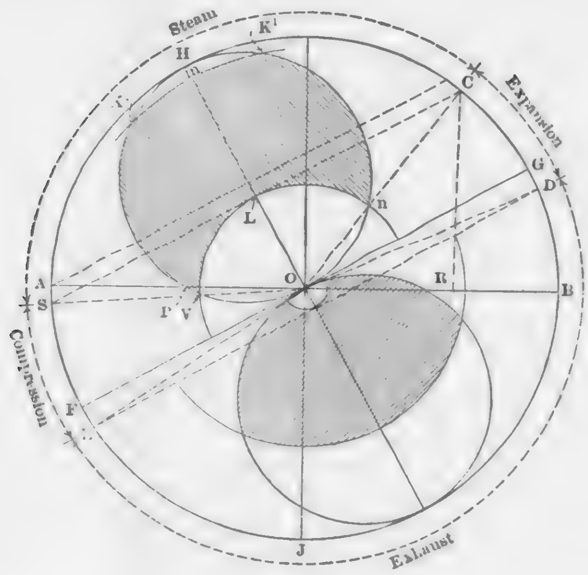


FIG 4.

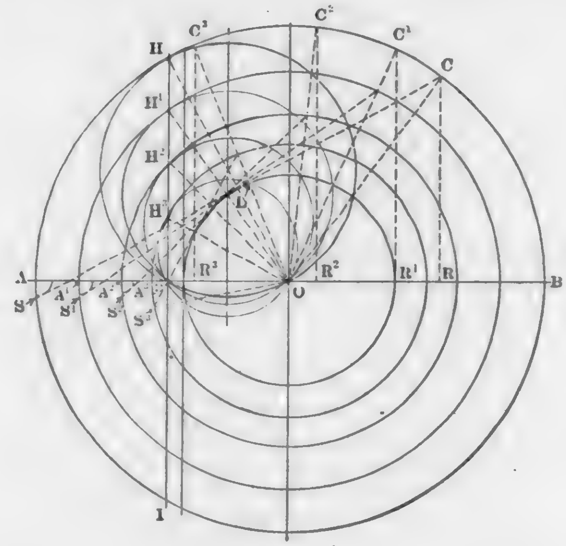


FIG. 5.

and the lap circle with the steam lap as a radius and find the intersection occurs at V, both with the circles and the previously laid down admission line OS and the cut-off point at the intersections at n. On the line OH set off the width of the steam port from L toward H equal to Lm and with Om as radius draw the arc KmK. The shaded figure enclosed by the letters VKK¹nL represents the steam port opening during the admission period and the width of the port opening at any desired position of the crank is found by measuring the distance radially from O between the lap and valve circles on the port line, as the case may be, on the desired crank position.

The exhaust openings are determined in the same manner and are shown on opposite side of FG, where the crank passes through the arc DJE during the exhaust period with a positive exhaust lap of the size EF. When the exhaust edge of the valve is line and line this arc becomes GJF or 180 degs., and when a negative lap (clearance) occurs, the duration of the exnaust period exceeds the half revolution of the crank. The various events are indicated around the eccentric circle on the figure as they take place during a complete turn of the crank.

In Fig. 5 the eccentric and admission valve circles are shown at different cut-offs where each set of lines and circles is governed by the same explanation as those of Fig. 4, where the admission points S, S^1, S^2, S^3 correspond to the closing positions C, C^1, C^2, C^3, cut-off points R, R^1, R^2, R^3, etc. On OH we have the full travel valve circle and OL the lap or radius of the lap circle, the latter being the same for all cut-offs as well as the lead, the radii H^1, H^2, H^3, etc., of the eccentric circles or diameters of the corresponding valve circles terminate on a line HI drawn perpendicular to AB and at a distance from O equal to that of lap and lead.

When the reverse lever is in its center position the diameter of the valve circle falls on the line AB and is equal to lap and lead. Continuing in back position we have the same method repeated and OI would be the full travel valve circle diameter, or the same as the eccentric radius for the valve travel. Any desired cut-off position may be laid out in same manner as that in Fig. 4, which shows all the valve events for a complete revolution of the axle.

The movements are in actual practice not so regular as the circles indicate, as it is impracticable to obtain the various loci in their theoretical positions; besides we have the angularities both of the main rods and the eccentric rods to contend with and whereby irregularities are entering in the problem that must be compensated for, as referred to in the general description. It is not to be considered that a uniform circular motion is the best, but an approximation to it works with less shocks or jerks, and is therefore more desirable for so high speed an engine as a locomotive. A few advantages can be taken, however, in selecting the suspensions and various connections, so that better results can be obtained than from a true circular motion, which are principally affected by three union points and are, first, the connecting point of eccentric rod and link; second, the locus of the lifting link suspension point; and third, the relative height of the crosshead connection point of the union bar to the corresponding point of the combination lever.

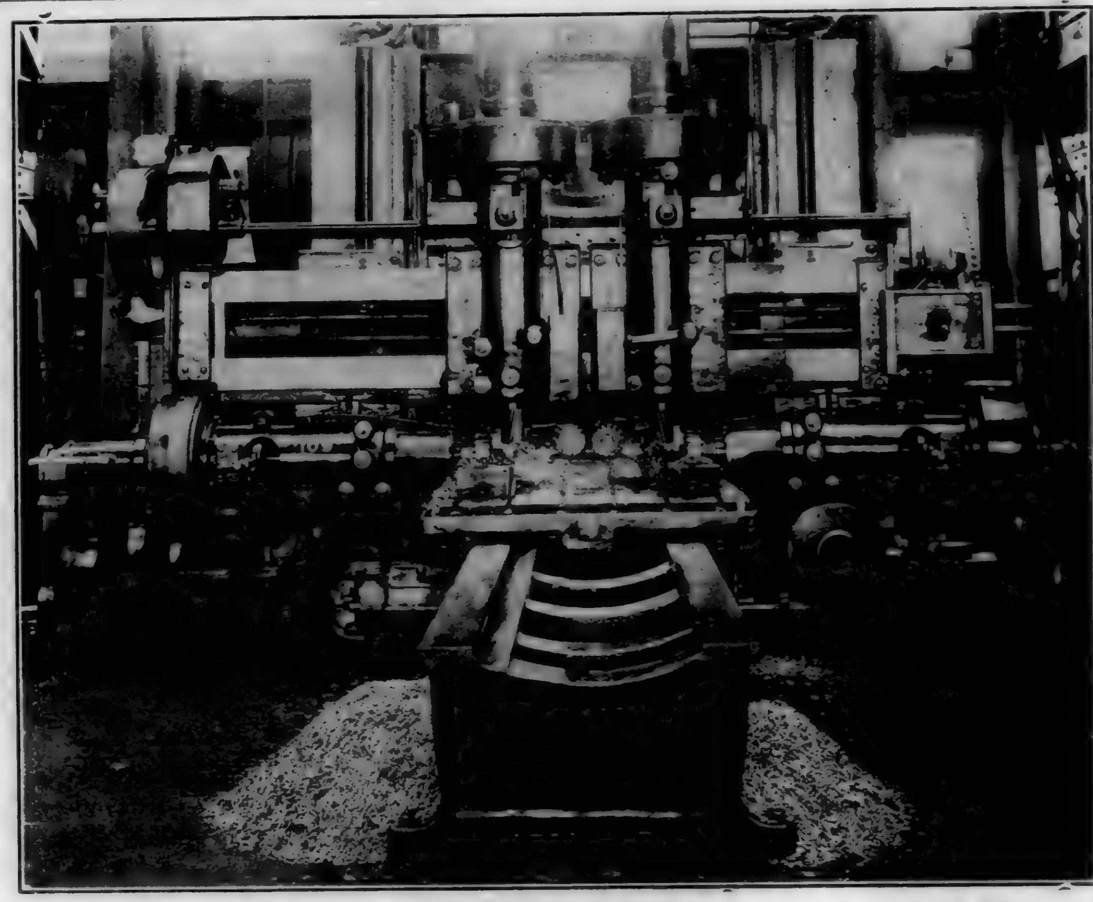
It is not necessary to lay out the valve diagrams except where a given cut-off per cent. is wanted. This is the most convenient way to find the required lap.

PRODUCTION IMPROVEMENTS.

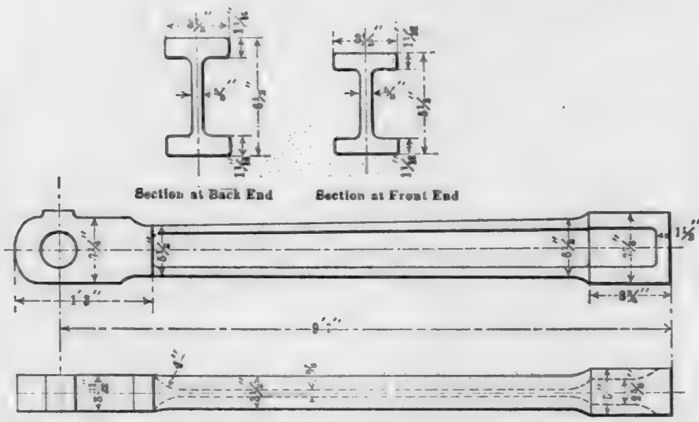
MILLING SIDE RODS.

The illustration shows a 5 by 5 by 12 ft. Ingersoll milling machine milling a set of main rods for the class D-11 ten-wheel locomotives at the Angus shops of the Canadian Pacific Railway. One of these main rods as it comes from the blacksmith shop weighs 1,009 lbs., and after it is removed from the milling machine its weight is 539 lbs., or in other words, 470 lbs. of metal are removed from each rod or 940 lbs. per set. By means of the side and vertical heads the bodies of these rods are paneled and the tops of the flanges, the sides of the rods and the flats of both the front and back stub ends are milled so that the only additional work to be done is the finishing of the sides and ends of the stub ends and the drilling. The sides of the rods are milled by the vertical head cutters. The panel is milled by the side head cutters, as shown in the illustration and the tops of the flanges of the panels and the flats of the stub ends are milled by the side head cutters shown laying on the table, which replace those used for milling the panels. The bottom and both sides of the rods shown on the machine have been finished and the pile of chips on the floor shows the amount of material removed from the rods before they were turned over. The panels are milled by an inserted plate type cutter 8 ins. in diameter and 3¼ ins. wide, operating at a speed of 25 r.p.m. with a table feed of 1⅝ ins. per min. The body of the rod as well as the panel is tapered, and it is necessary to set one side of the rod straight and mill the panel, and then mill the straight side with the vertical head cutter. The rod is then set over to get the other side straight, and the panel is completed and the vertical head finishes the side. The top of the rod is then finished.

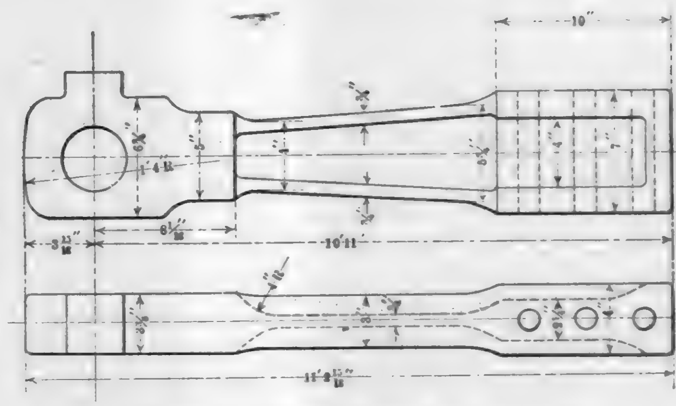
The main rods for switch engines, class U-3-C, are not quite as heavy as the rods for class D-11, and as the panels are not



MILLING CONNECTING RODS ON INGERSOLL MILLING MACHINE AT THE ANGUS SHOPS.



CONNECTING ROD FOR CLASS D-11 ENGINES.



CONNECTING ROD FOR CLASS U-3-C ENGINES.

as wide or deep the method of handling these rods varies somewhat from that above. These rods as they come from the blacksmith shop weigh 822 lbs. each, and after they are milled weigh only 416 lbs., or the machine removes 406 lbs. of metal from each rod, or 812 lbs. per pair. As the panel is considerably smaller than for the D-11 rods, it is possible to work both the vertical and horizontal cutters at the same time, although they are operated at a lower feed than that used on the D-11 rods. These vertical cutters are solid, 4 ins. in diameter and 6 ins. long. They are set ahead of the side cutters, and as soon as they have worked far enough ahead the panel cutters in the horizontal heads, which are of the inserted plate type 8 ins. in diameter and 2¼ ins. wide, are set to work operating at a speed of 25 r.p.m. With the four cutters at work the table speed is reduced to 1¼ ins. per min. When near the ends of the rods the vertical cutters are raised up out of the way and the side head cutters finish to the end of the panel.

To finish the panels on the two sides of the rod and mill both sides of the D-11 rods, the table is fed six times, and a heavy feed is used for the panels; while with the U-3-C rods the same work is done and the table is fed only four times, although a lighter feed is used for panelling. Side rods are also milled on this machine and with less setting, as they are straight in both the body and the panel. The machine is belt-driven and it is aimed to keep it running at its full capacity just as large a proportion of the time as it is possible.

EXPANDING CHUCK FOR TRUCK WHEEL TIRES.

The expanding chuck for 40-in. tires, shown in Fig. 1, is in use at the Angus shops of the Canadian Pacific Railway. The tires which they use for their 40-in. wheels have retaining rings on both sides, and, it is, of course, necessary that the grooves for these rings be accurate in their relation to each other and to the outside of the wheel. The tires are first placed on the table of a 51-in. boring mill and are set to run true from the outside, and they are then bored and are grooved on the top side. They are then removed and are placed over the expanding chuck on another boring mill, are quickly chucked by tightening the nut on the 1½-in. bolt and are grooved on the other side. The expanding chuck has a lug on the bottom that fits in the table and is self-

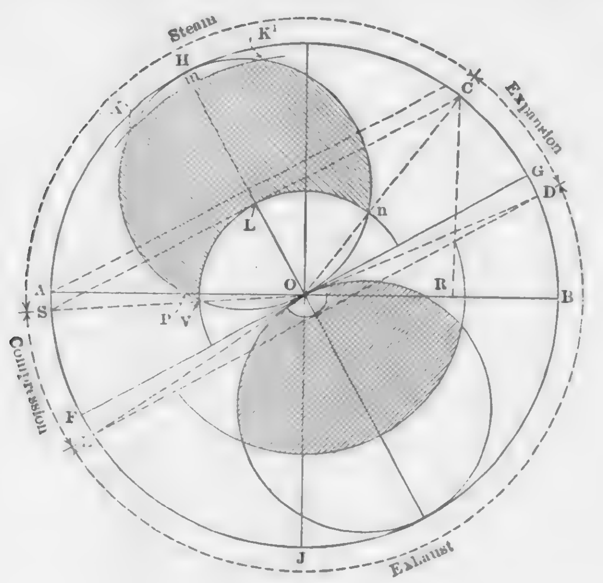


FIG 4.

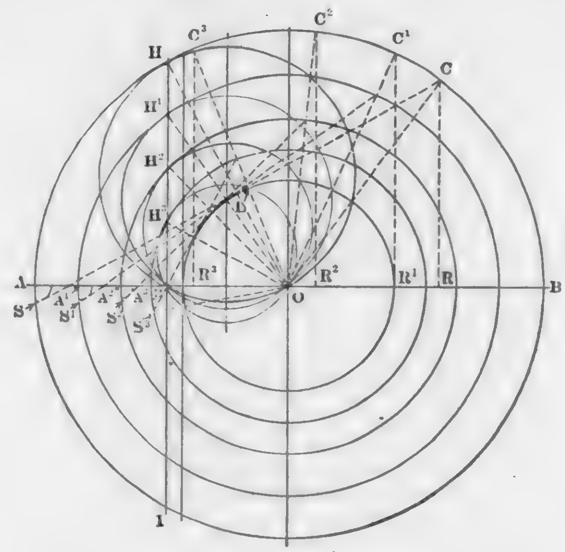


FIG. 5.

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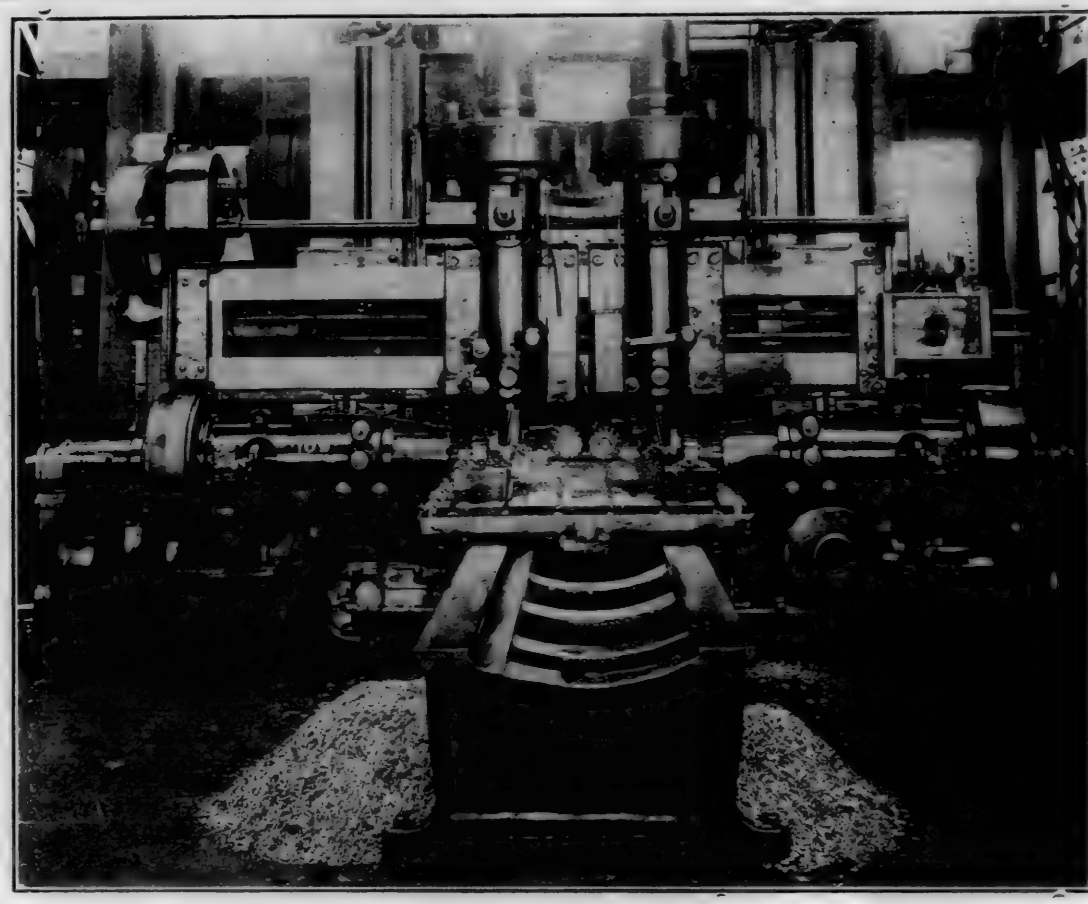

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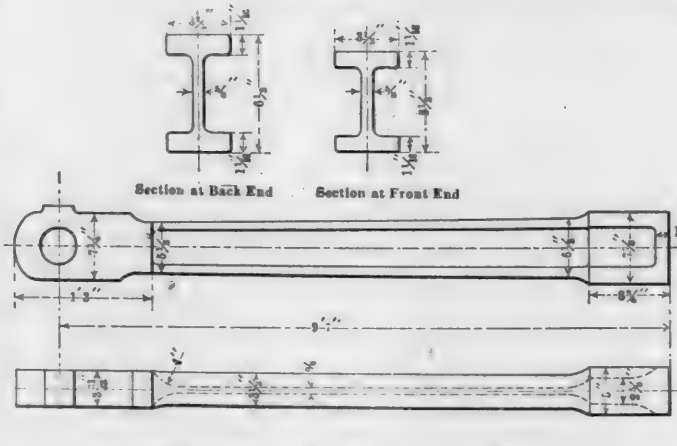

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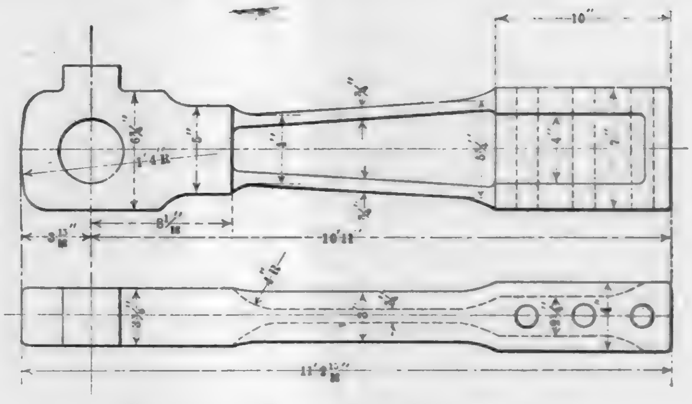

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To finish the panels on the two sides of the rod and mill both sides of the D-11 rods, the table is fed six times, and a heavy feed is used for the panels; while with the U-3-C rods the same work is done and the table is fed only four times, although a lighter feed is used for panelling. Side rods are also milled on this machine and with less setting, as they are straight in both the body and the panel. The machine is belt-driven and it is aimed to keep it running at its full capacity just as large a proportion of the time as it is possible.

EXPANDING CHUCK FOR TRUCK WHEEL TIRES.

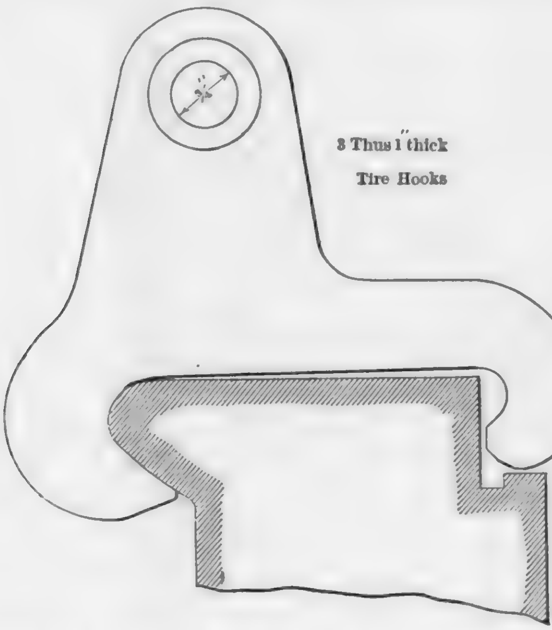
The expanding chuck for 40-in. tires, shown in Fig. 1, is in use at the Angus shops of the Canadian Pacific Railway. The tires which they use for their 40-in. wheels have retaining rings on both sides, and, it is, of course, necessary that the grooves for these rings be accurate in their relation to each other and to the outside of the wheel. The tires are first placed on the table of a 51-in. boring mill and are set to run true from the outside, and they are then bored and are grooved on the top side. They are then removed and are placed over the expanding chuck on another boring mill, are quickly chucked by tightening the nut on the 1½-in. bolt and are grooved on the other side. The expanding chuck has a lug on the bottom that fits in the table and is self-

centering, thus it takes but a very short time to place it on the machine. The tire hook, shown in Fig. 2, is used for putting the tires over this chuck, and for removing them.

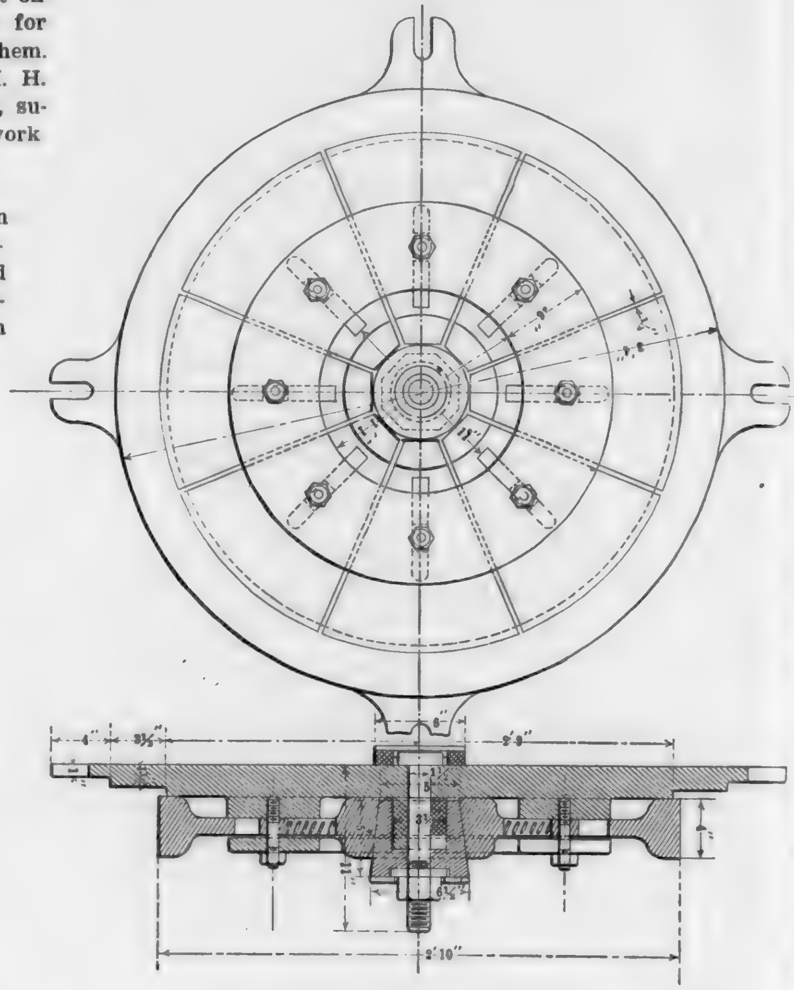
We are indebted for the above information to Mr. H. H. Vaughan, assistant to the vice-president, Mr. H. Osborne, superintendent of shops, and Mr. Gustave Giroux, piece work inspector.

MILLING TEETH IN REVERSE LEVER QUADRANTS.

On page 228 of our June issue, in connection with an article on vertical milling machines in railroad shops, mention was made of a device used on the Becker-Brainard vertical milling machine at the Concord shops of the Boston & Maine Railroad for accurately milling the teeth in reverse lever and throttle lever quadrants. This device is shown in detail in the accompanying illustration. The arms B, which hold the quadrant A, may be adjusted to suit the length of the radius of the quadrant. The cutters in the tool holder H, are made to suit the shape of the teeth in the quadrant, and the tooth is cut as the table of the machine is fed forward. The quadrant is then dropped downward or moved upward a tooth and is held by the steel catches F or G, as the case may be, which regulate the space between the teeth. K is a set screw which securely holds the quadrant in place. C is a wrought iron support for the arms B; D is an angle iron which is fastened to the table and to which the support C and the casting E are attached. The device is simple and is giving very satisfactory results. We are indebted for this information to Mr. Louis A. Abbott.



HOOK FOR HANDLING TIRES ON AND OFF OF EXPANDING CHUCK.



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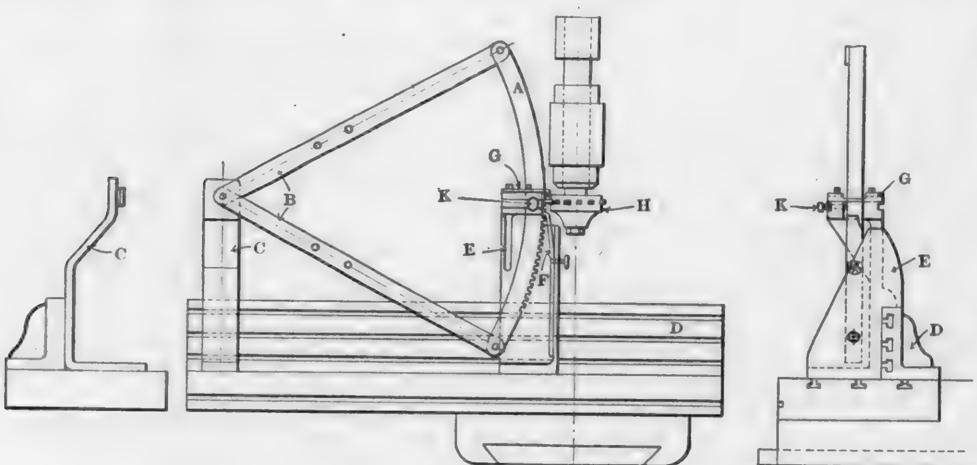

DEVICE FOR MILLING TEETH IN REVERSE LEVER QUADRANTS.

TRACTION EXPERIMENTS.—Traction experiments with ordinary farm wagons have been made for the past three years by the Civil Engineering Department of the Iowa State College, and very valuable data have been obtained. The average pull in pounds per ton on an old and very dirty gravel road in the worst spring condition is about 190 to 200 lbs., and on a better gravel road in the same condition about 135 to 150 lbs. The traction on these roads in ordinary dry condition is between one-third and one-half the amounts mentioned. On earth roads in the worst spring condition the pull per ton ranges from 234 to 531 lbs., averaging about 330 lbs. In dry weather the pull on these roads is from 83 to 215 lbs., averaging about 125 lbs. These tests were made with farm wagons having 42 and 52-in. wheels and 1¾-in. tires, and show clearly the effect of bad roads on traction.

HEAVY RAILS.—The rails on the belt line railroad around Philadelphia are said to be the heaviest in the world, weighing 142 lbs. per yard, or 17 lbs. more than any previously used. They are ballasted in concrete, with 9-in. girders to bind them.

MIKADO TYPE FREIGHT LOCOMOTIVE—DEEPWATER RAILWAY COMPANY.

MIKADO TYPE FREIGHT LOCOMOTIVES.

DEEPWATER RAILWAY COMPANY.

The Deepwater Railway Company is receiving from the Baldwin Locomotive Works some Mikado type freight locomotives, which, considering their weight, are very powerful. These engines have a slightly greater tractive power than the tandem compound Mikado type locomotives for the Northern Pacific Railway, described on page 367 of our October issue. The Deepwater locomotives, with 22 by 28-in. cylinders, have driving wheels only 51 ins. in diameter, and are apparently intended for slow, heavy service, and will probably be used at Allegheny Summit and on some of the heavy mountain grades in West Virginia. The Rushton trailer truck is used. The leading dimensions of these engines are as follows.

MIKADO TYPE FREIGHT LOCOMOTIVE.

DEEPWATER RAILWAY COMPANY.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Freight.
Fuel	Bituminous coal.
Tractive power	45,180 lbs.
Weight in working order, estimated	224,000 lbs.
Weight on drivers, estimated	180,000 lbs.
Weight of engine and tender in working order, estimated	340,000 lbs.
Wheel base, driving	14 ft.
Wheel base, total	31 ft., 1 in.
Wheel base, engine and tender	59 ft.
RATIOS.	
Tractive weight ÷ tractive effort	3.98
Tractive effort x diam. drivers ÷ heating surface	674.
Heating surface ÷ grate area	66.9
Total weight ÷ tractive effort	4.95
CYLINDERS.	
Kind	Simple.
Diameter and stroke	22 by 28 in.
VALVES.	
Kind	Balanced Slide.
WHEELS.	
Driving, diameter over tires	51 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	9½ by 12 ins.
Driving journals, others, diameter and length	9 by 12 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	5½ by 10 ins.
Trailing truck wheels, diameter	36 ins.
Trailing truck, journals	6 by 10 ins.
BOILER.	
Style	Straight.
Working pressure	200 lbs.
Outside diameter of first ring	78 ins.
Firebox, length and width	102 by 72 ins.
Firebox depth	front 72 ins., back 62 ins.
Firebox plates, thickness	⅜, 7/16 and ½ in.
Firebox, water space	5 in. front, and 4 in. sides and back.
Tubes, number and outside diameter	300-2¼ ins.
Tubes, gauge and length	11, 18 ft. 6 ins.
Heating surface, tubes	3,254 sq. ft.
Heating surface, firebox	160 sq. ft.
Heating surface, total	3,414 sq. ft.
Grate area	51 sq. ft.
TENDER.	
Wheels, diameter	33 ins.
Journals, diameter and length	5 by 9 ins.
Water capacity	6,000 gals.
Coal capacity	10 tons.

HIGH SPEED STEEL MILLING CUTTERS.

The following extracts are taken from a very complete and valuable paper on "The Practical Use and Economy of High Speed Steel," presented by Mr. J. M. Gledhill of Armstrong, Whitworth & Co., Ltd., Manchester, England, before the Glasgow and West of Scotland Foreman Engineers and Ironworkers' Association.

ANNEALING.

When making tools that require to be machined or cut to form, it is of course necessary to have the steel carefully and uniformly annealed, or softened, to facilitate machining operations. The process of annealing is one of much importance, and is best performed in specially designed sealed furnaces, constructed as "Muffles," so that the required heat is obtained uniformly by radiation, and the flame does not impinge on the steel. In addition to softening the steel and rendering it easy to machine, annealing has the effect of bringing the steel into a more uniform and homogeneous condition by eliminating the molecular strains which are set up in hammering and rolling, so that when the finished steel is heated preparatory to hardening, equal expansion follows, and also equal contraction when cooled It will thus be seen that should the steel be not annealed uniformly throughout, risks of tools cracking or warping in hardening are very considerably increased.

For finished and expensive tools of intricate or irregular shape in which unequal expansion and contraction are likely to operate suddenly, it is advisable to re-anneal such tools before hardening so as to release any strains that may have been set up by machining, and thus leave the metal in as normal a condition as possible, so minimizing any tendencies towards cracking or warping, especially the latter, after hardening.

HARDENING AND TEMPERING.

With regard to the hardening and tempering of specially formed tools of high-speed steel, such as milling and gear cutters, taps, screwing dies, reamers, and other tools that do not permit of being ground to shape after hardening and where any melting or fusing of the cutting edges would be fatal, and must be prevented, the method of hardening is as follows: A specially arranged muffle furnace (illustrated in Fig. 1) heated either by gas or oil and consisting of two chambers lined with fireclay is employed, the gas and air entering through a series of burners at the back of the furnace, and so under control that a temperature up to 2,200 deg. F. may be steadily maintained in the lower chamber, whilst the upper chamber is kept at a much lower temperature.

The mode of procedure is now as follows: The cutters are first placed upon the top of the furnace until they are warmed through, after which they are placed in the upper chamber and thoroughly and uniformly heated to a temperature of about 1,500 deg. F., or say, a medium red-heat, when they are transferred into the lower chamber and allowed to remain therein until the cutter attains the same heat as the furnace itself, viz., about 2,200 deg. F., and the cutting edges show a bright yellow heat, having an appearance of a glazed or greasy surface. The cutter should then be withdrawn whilst the edges are sharp and uninjured, and revolved before an air blast until the red has passed away, and then whilst the cutter is still warm—that is, *just* permitting of its being

handled—it should be plunged into a bath of tallow at about 200 deg. F. and the temperature of the tallow bath then raised to about 520 deg. F., on the attainment of which the cutter should be immediately withdrawn and plunged in cold oil, or preferably if the cutter is a large one, allow it to cool with the tallow to normal temperature. When blast is not available small cutters may be hardened by quenching in oil from yellow heat.

There are, of course, various other ways of tempering, a good method being by means of a specially arranged gas-and-air stove into which the articles to be tempered are placed, and the stove then heated up to a temperature of from 500 deg. F. to 600 deg. F., when the gas is shut off and the furnace with its contents allowed to slowly cool down. It is most important that the initial heating of the article to be hardened should be slowly and thoroughly effected, for unless the heating be uniform the expansion will be unequal and the risks of cracking and warping greatly increased.

SELECTION OF STEEL FOR CUTTERS.

Few shop tools are more expensive to make and maintain than milling cutters, and it is therefore of the utmost importance that the steel from which they are to be made shall be of the highest possible quality, for the cost of the steel is frequently but a small fractional part of the cost of the finished cutter, making it decidedly risky—and of more than doubtful economy—to use steel other than the best obtainable,

MAKING HEXAGON NUTS FROM ROLLED BARS.

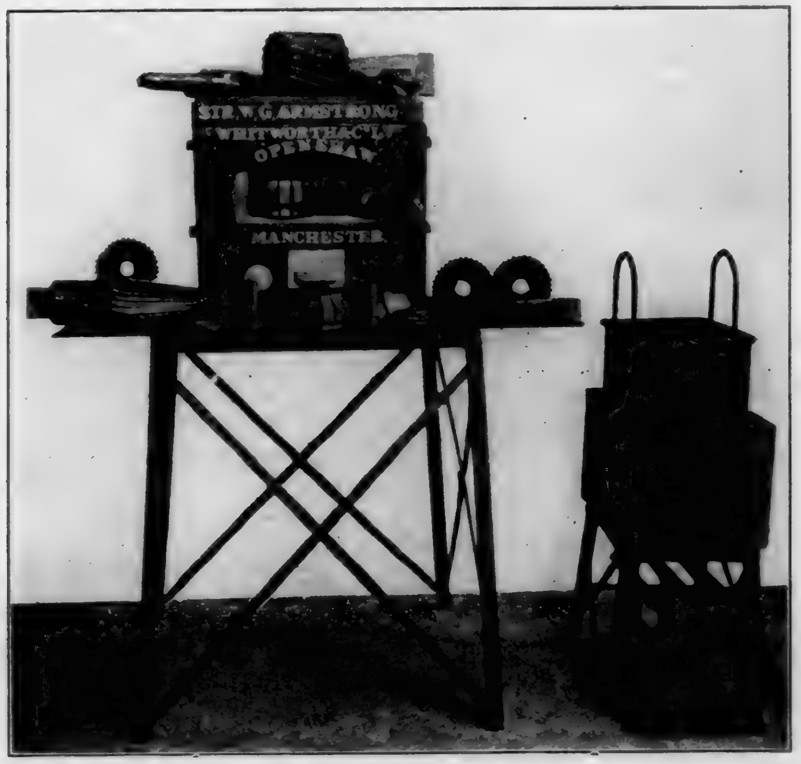

FIG. 1—MUFFLE FURNACE FOR HARDENING MILLING CUTTERS, ETC., OF "AW." HIGH SPEED STEEL.

CIRCULAR FURNACE FOR HARDENING LARGE CUTTERS.

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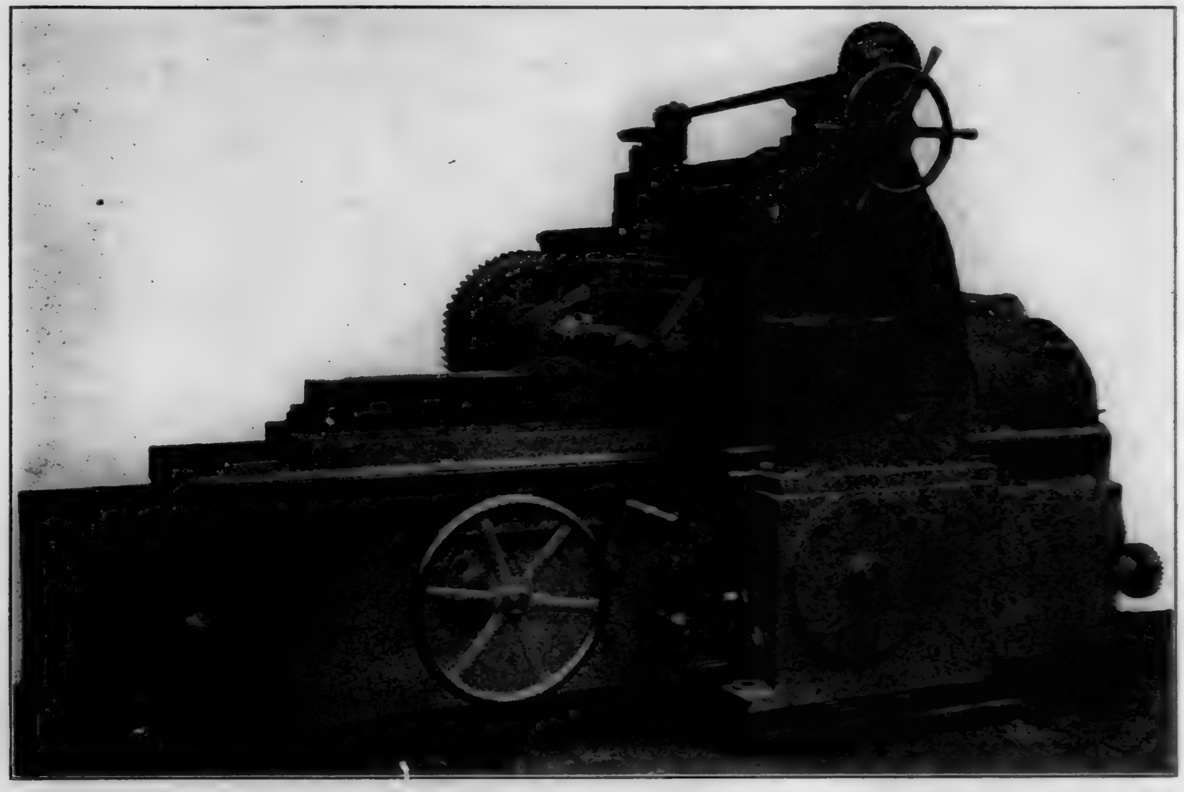

HIGH SPEED SLAB MILLING MACHINE WITH 40 H.P. MOTOR; "A W." CUTTERS CUTTING STEEL AT 180 FT. PER MINUTE; ½ IN. DEPTH OF CUT, 7½ IN. WIDTH; FEED, 6 IN. PER MIN.

completely worn down, for it to be annealed, so that it may be re-cut. It is very largely because of this that steel of the greatest purity should be used, otherwise marked deterioration will be observed each time the cutter is re-hardened—even should cracking be avoided. Some recent tests of this character showed less than 5 per cent. loss of efficiency in the "A W." steel after seven times annealing and hardening of the same piece of metal.

Steel for use in milling and gear cutters should be reasonably tough, with a capacity for retaining a sharp cutting edge, and combined with great powers of endurance, for if the edges become quickly dulled greater power will be required, while the resulting finish of the work will not be of a satisfactory character, and since the grinding and setting up of a milling cutter is comparatively a more or less costly operation, only steel possessing qualities as enumerated above should be used if good results and economies are to be effected. The following will clearly show the very great advantages to be derived from the use of cutters made from high-speed steel.

PRACTICAL RESULTS.

Operating on rolled steel bars with cutters of "A W." steel a total of 90 hexagon nuts for 3⅜-in. diameter bolts are produced each day (Fig. 2.). The cutting speed is 150 ft. per minute; maximum depth of cut, ⅝ in.; width, 7 ins.; 675 lbs. of metal being removed per day. The cutters are 8 ins. diameter, and usually mill 300 nuts without grinding. Owing to the intermittent character of the cut, these cutters are very severely tried indeed, but so far have answered admirably. It may be here noted that these cutters effected such a great saving in costs and machines as to repay the cost of making same after less than two days' work.

Another really remarkable piece of milling work is evidenced by the following extract from a letter received from Cleveland, Ohio: "We have made a 2½-in. diameter, ¾-in. face, 12 x 53 deg. cutter from the 'A W.' steel blank, and used it on milling spiral mills made from annealed tool steel; depth of cut was 5-16 in.; cutting speed, 62 feet per minute. .024-in. feed per revolution = 2.28-in. per minute; 924 ins. were cut, the cutter showing no signs of wear. Speed was then increased to 113.2 ft. per minute with a feed of .024 in. per revolution = 4.15 ins. per minute, and after cutting another 924 ins. the cutter was still in fairly good condition and would have milled many more if the class of work had not required a clean and smooth cut. The cutter was then reground, only requiring .003 in. grinding to sharpen. I consider this test and the result thereof the very best in my experience."

Length of time for first operation....................	6¾ hours.
Length of time for second operation..................	3¾ hours.
Total length of time for both operations..........	10½ hours.

NEW BALTIMORE AND OHIO CONSOLIDATION LOCOMOTIVES.

BY J. E. MUHLFELD.

The following features were considered in the design, construction, maintenance and operation of the E-27 class, consolidation type locomotives for the Baltimore & Ohio Railroad.

A reasonable first cost, maximum efficiency for the service; within the track, weight and clearance requirements; the greatest proportion of adhesive to total weight; a capacity to handle the heaviest gross tonnage practicable at the highest desired speed; economy as regards maintenance and fuel and water consumption; a substantial construction and of the least number of parts and a capacity to perform continuous service without liability of failure. A general design of freight locomotive, suitable for handling heavy tonnage at fast or slow speeds, over level and mountainous, open and tunnelled railroad of varying curvature and gradient. A boiler of simple design and substantial construction, with ample grate area (in one plane) and firebox heating surface, together with provision for the free circulation of the water and the unrestricted passage of the gases, and suitable for the consumption of a cheap grade of run of mine, bituminous coal. A maximum tractive effort for starting trains with the least number of revolutions of driving wheels per mile run. The shortest rigid wheel base consistent with driving wheels of 62 ins. maximum diameter, together with a maximum weight on drivers permissible with clearance and weight, and in view of maintaining sufficient weight on

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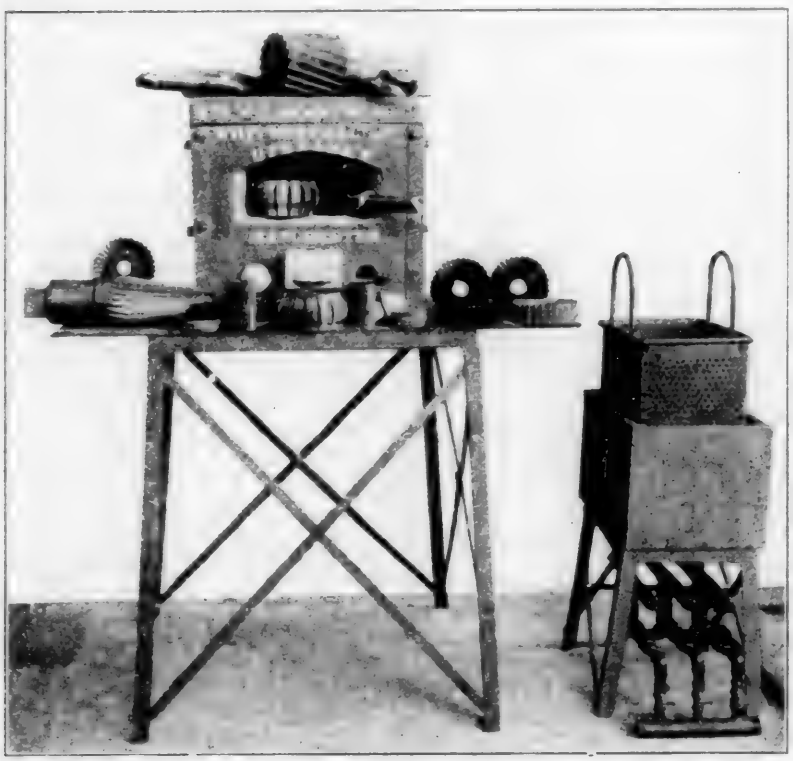

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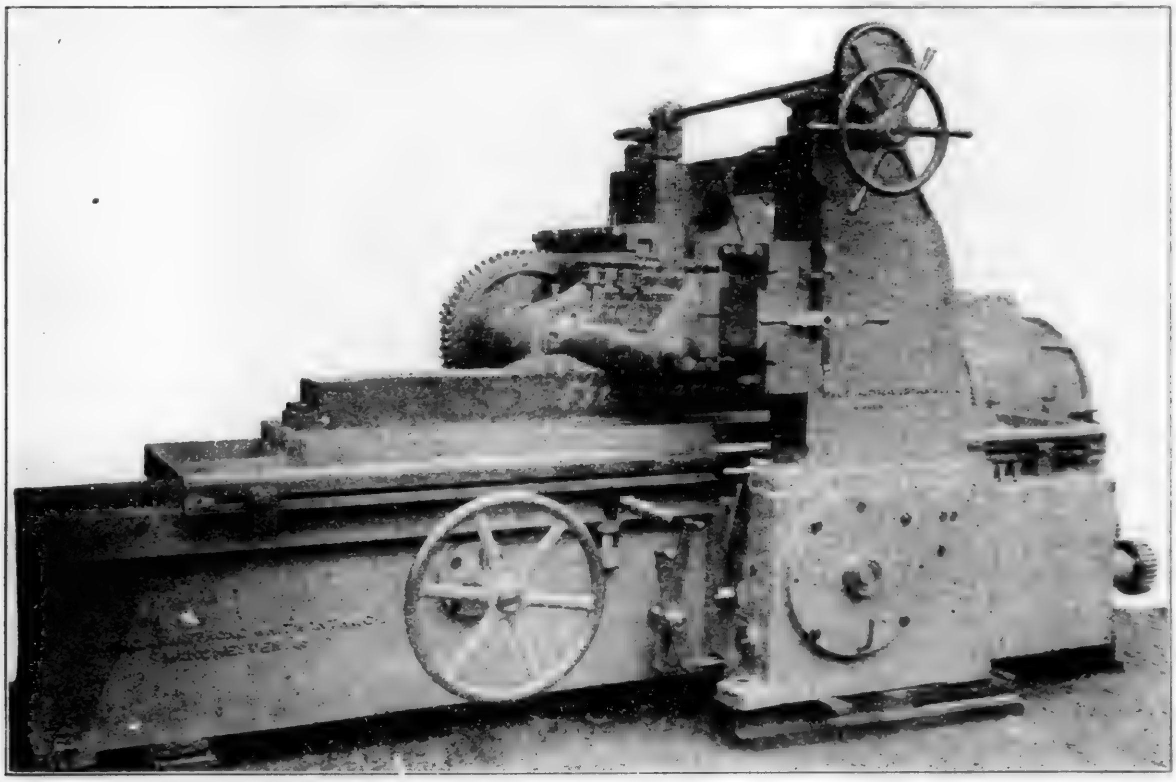

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the pony truck wheels to secure safe tracking qualities for high speed down mountainous lines of considerable curvature and gradient.

Bushings applied to the cylinders in the initial construction, to secure a good wearing metal for the piston, as well as strong walls and a suitable metal for the strength required in the cylinder and the saddle casting. A half saddle with front and back flanges extending down to the lowest position in a line with the center of the cylinder, and the half saddles well-bolted with staggered bolts in deep front and back flanges to reduce the liability of one half the cylinder casting loosening from the other half.

Frames of a strong section in width and depth, with large radii at the junction of the main rails and the pedestals to insure against concentration of stresses and breakage; substantial connections and keying lugs between the main and front frames and the cylinders; a good fastening of the boiler to the frames and cylinders; a substantial cross bracing between the frames and to secure the frames to the boiler; a substantial deck casting to cross brace the frames at the rear of the boiler.

An arrangement of equalized pressure driver brake that will admit of the brake shoes being applied to the front of the wheels to relieve reverse stresses to the spring and equalizing gear, and at the frames where the brakes are applied; reverse lever, throttle lever, engineer's brake valve, straight air brake valve, injectors, sand lever, whistle lever valve, water gauge cocks, water glass, steam blower valve, ash pan blower valve, cylinder cock operating lever, etc., within convenient reach of the engineer when sitting on the cab seat. The arrangement of the rocking grate shaker levers, ash pan damper levers, and the operation of the furnace doors and the distance between the fire hole and the tender coal gates has been given considerable attention, with a view of making the same convenient for the firemen. The coal space in the tender has been arranged, so that all the coal will be brought forward, as near the coal gates as practicable, by gravity.

A crosshead arrangement so that the vertical wear may be taken up without disturbing the alignment of the guides. An arrangement of piston rods and guides, so that the metal packing may be applied when the crank pins are on the front dead center, and so that the piston packing rings can be applied without disconnecting the piston rod from the crosshead; slide valves having 1¼ ins. outside and ⅛ in. inside lap, with 1/16 in. lead in full go ahead and back-up gear with 2¾ in. throw of the eccentric, in connection with a motion gear of the most simple design and construction, and the fewest number of bearing parts consistent. Five of these locomotives will be equipped with the Walschaert motion

CONSOLIDATION LOCOMOTIVE—BALTIMORE & OHIO RAILROAD.

also to permit of the application of a push-down type of driver brake cylinders and cranks to the frame at the rear of the driving wheel, where they will be accessible for repairing, cleaning and adjustment. We consider that the application of driver brake cylinders between the frames and at the rear of the cylinders, interferes with the substantial bolting and accessibility to the frame splices and takes up space that is desirable for inspection, and causes stresses at that point which are undesirable. An ample storage of compressed air in two reservoirs of combined 60,000 cu. ins. capacity, embodying good radiating and condensing surfaces, which in connection with an 11-in. air pump, should fully meet the requirements for the proper handling of the longest trains on a level track and on down mountainous grades.

A heavy section of main and side rods around the brasses, knuckle joint pin and other openings. The elimination of unnecessary piping from the outside of the boiler, which is liable to leakage and to obscure the vision of the engineer. Substantial and positive grate shaking gear, ash pan dampers, furnace doors, self-cleaning ash pans, etc. Steam balanced piston packing rings to the pistons, to reduce the wear of the cylinders and the packing rings and to maintain the piston in a tight condition; steam balanced slide valve balance strips, to insure the least wearing of the strips and the grooves in which they are contained.

A convenient and roomy cab, well-ventilated for tunnel service, and having the lubricator, steam and air gauges, gear, similar to that applied to the Mallet articulated locomotive No. 2400, for the purpose of making comparison and determining as to the advisability of future applications of the Walschaert gear, instead of the Stephenson. Brass eccentric straps and brass shoes and wedges in connection with cast steel driving boxes. A substantial design of driving wheel centers with the maximum bearing face between the tire and the wheel center. All bearing surfaces of the boiler expansion braces, running and equalizing gear, brake gear, motion gear, etc., are case-hardened and of wrought iron, or open-hearth steel.

A tender underframe of deep section channel, with the cistern equipped with collision angle and iron coal gates, to reduce the liability of the tank or coal being forced ahead over the tender frame in event of accident. The cistern designed with a deep water bottom extending to the extreme front of the tender frame, in order to maintain an ample proportion of weight over the front tender trucks at all times.

The constuction of the first or sample locomotive No. 2500, which was put into service during the month of August, was carried on in advance of the regular order, to give an opportunity for discussion and a practical demonstration of the design, construction and operation, the result of which might lead to discussion that would affect the balance of the locomotives. The motive power department appointed three committees, one consisting of the superintendents of motive power, mechanical engineer and engineer of tests and shop

master mechanics; another of the division master mechanics, and the third of the road foreman, each bringing with them one locomotive engineer and fireman of each division. After the arrival of the sample locomotive at Baltimore, certain parts were removed, and the members of these committees were given every opportunity to make an examination of the details in the general design and construction. The locomotive was then connected and put under steam, so that the members of the committees could have an opportunity to observe as to the operation, hauling capacity and steaming and riding qualities. The committees were instructed to submit reports after their investigation, giving their criticisms and recommendations and reasons for any changes that they would suggest making.

These reports contained many valuable suggestions, which, coming from the people who will be in direct charge of the maintenance and operation of the locomotives over level and mountainous divisions, have been of considerable benefit in producing a design that the motive power people feel will give the most satisfactory general results. It is felt that this method of producing motive power equipment by a combination of drawing office and practical shop and operating knowledge of locomotive design and construction, will result to the best advantage.

In deciding upon the types of new locomotives to be built and in designing, we have thought that only those of maximum power should be considered, and that the fewest number of standard types adapted to the present and future needs of the different service and to meet the contemplated physical improvements of the property should be decided upon. With the above in mind, it was decided to classify the 250 locomotives into three groups, five being a switching type for special service, thirty-five, a Pacific type for passenger and fast freight service, and 210 of the consolidation type for slow and fast freight service.

As the principal work to be accomplished by a railroad is the movement of its trains from one terminal to another on time, we have thought that the monthly mileage that can be derived from any class of properly designed, constructed and maintained motive power, is limited only by the terminal delay and the despatch with which it can be handled over a division, even though the speed, grade and curvature are factors that may largely control the loading of the locomotives, as well as the cost of their operation. With the demand for faster schedules, we have followed out the general tendency and more desirable practice of increasing the diameter of the driver wheels and the length of the stroke, which, combined with a proportionately reduced diameter of cylinder, results in less liability for wear and tear on the track and locomotives, and decreased operating expense due to less revolutions per coupled wheel per mile, and a material gain in reduced boiler and machinery stresses.

The demand for great locomotive tractive power in one unit, has frequently resulted in the use of extreme diameters of cylinders, reduced spread of frames, increased distance between centers of cylinders and greater length of rigid wheel base, which proportions have transmitted stresses to the cylinders and connecting frames, that have resulted in a large number of breakages of these parts. Furthermore, the failure of the higher steam pressure to produce efficient and economical results, in many modern locomotives, has frequently been due to defective boiler, cylinder, frame and motion gear design and construction; excess weight and inferior quality of material applied to frictional parts; neglect in the details of design; inadequate provision for drifting and condensation, priming, method for lubrication, etc. We have kept in mind, that when the steam pressure is not maintained, a locomotive cannot develop its working power, and that the modern type is under the further disadvantage of having to haul an increased dead weight, especially on mountainous grades. Therefore, by combining in the new construction, features that we have found from practical experience have met the local conditions, and through the elimination of individual preferences and frills, we believe that a plain, simple, practical design and construction has been produced that will give generally satisfactory results.

The general dimensions of the consolidation locomotives, which are being built by the American Locomotive Company, are as follows:

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Freight.
Fuel	Bituminous coal.
Tractive power	41,100 lbs.
Weight in working order	208,500 lbs.
Weight on drivers	185,900 lbs.
Weight on leading truck	22,600 lbs.
Weight of engine and tender in working order	345,900 lbs.
Wheel base, driving	16 ft. 8 in.
Wheel base, total	25 ft. 7 ins.
Wheel base, engine and tender	59 ft. 8¼ ins.
RATIOS.	
Tractive weight ÷ tractive effort	4.52
Tractive effort x diam. drivers ÷ heating surface	888.
Heating surface ÷ grate area	49.1
Total weight ÷ tractive effort	5.07
CYLINDERS.	
Kind	Simple slide valve.
Diameter and stroke	22x30 ins.
Piston rod, diameter	4 ins.
VALVES.	
Kind	Richardson Balance.
Greatest travel	6 ins.
Steam lap	1¼ in.
Exhaust lap	⅜ in.
Setting	1/16 in. lead in full gear front and back.
WHEELS.	
Driving, diameter over tires	60 ins.
Driving, thickness of tires	3 ins.
Driving journals, main, diameter and length	10x13 ins.
Driving journals, others, diameter and length	9½x13 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	6 by 10 ins.
BOILER.	
Style	Straight top.
Working pressure	200 lbs.
Outside diameter of first ring	74 7/16 ins.
Firebox, length and width	108⅛x75¼ ins.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	4½ ins.
Tubes, number and outside diameter	282, 2¼ ins.
Tubes, gauge and length	11, 15 ft. 10 ins.
Heating surface, tubes	2,612.80 sq. ft.
Heating surface, firebox	162,26 sq. ft.
Heating surface, total	2,775.06 sq. ft.
Grate area	56.5 sq. ft.
Exhaust pipe	Single, 5¼ and 5½ in. nozzle.
Smokestack, diameter	18 ins.
Smokestack, height above rail	14 ft. 7¾ ins.
Centre of boiler above rail	118 ins.
TENDER.	
Tank	Water Bottom.
Frame	13-in. channels and plates.
Wheels, diameter	33 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	7,000 gals.
Coal capacity	12 tons.

RESULTS OF MOTOR DRIVEN TOOLS AT THE McKEES ROCKS SHOPS.

During 1903 and 1904 we devoted considerable space to a description of the McKees Rocks Shops of the Pittsburg & Lake Erie Railroad, and to their equipment, and especially to the application of individual motors to both the old and new machine tools. This was one of the first railroad shops where machine tools were extensively equipped with individual motors, and as they have now been in operation for about two years, the following results, which are taken from a paper on "Machine Tool Practice," read by Mr. G. M. Campbell, electrical engineer of the railroad, before the Engineers' Society of Western Pennsylvania, are of interest:

One argument often brought up against the old belt-driven shop was the great waste of power, and the same is brought up against the use of individual motors as against group driving on account of the lower efficiency of small motors, but the argument is not worth considering when the total amount of the power consumed is taken account of. The cost of power is very rarely 2 per cent. of the cost of the output in shops of any size. Suppose by the strictest economy 50 per cent. of the cost of power could be saved, yet the net saving would be only 1 per cent. During the year 1904 the total cost for power at the Pittsburg & Lake Erie shops was slightly over one-half of 1 per cent. of the cost of the labor and material.

Some information concerning the motor equipped shop of the P. & L. E. R. R. at McKees Rocks may be of interest. The shops are compactly situated and consequently direct current

could be used to advantage; the voltage in use is 250. For machine work, the multi-voltage system of drive is used and with excellent results. The voltages vary by steps of 40 from 40 to 240, with intermediate and additional steps obtained by means of field resistance. The controllers in use have 21 steps in forward motion, giving approximately 10 per cent. increments. Individual motor drive was carried to a much greater extent than in any shop previously put up, but experience has not shown that any mistake was made in so doing. In the machine shop only one small group of tools is driven from shafting. All the others have individual motors. The tools in the group above referred to are such tools as drill grinders, polishers, bolt threading machines, etc. In the wood working shops, however, group driving is the rule; individual motors are used only on the larger machines; in general in machines of this class no change in speed is required and therefore group driving is entirely satisfactory.

The complete list of all motors installed numbers 83. This list of motors shows sizes as follows:

Number.	Rating.	Total H. P.
1	2	2
6	3	18
6	4	24
11	5	55
3	6	18
16	7½	120
1	9	9
10	10	100
1	13	13
13	15	195
3	20	60
7	25	175
3	35	105
1	45	45
1	60	60
83		1000

It should be noted that the rating is for full speed and voltage, not the actual horsepower obtainable at all times and not the horsepower required by the machines. The horsepower rating for the variable speed machines would be only 40 to 50 per cent. of the motor rating. The other motors around the plant would add about 450 h.p. and the cranes about 250 h.p., bringing the total motor rating up to about 1,700 h.p. Of the 83 motors, 75 are used for individual drive and 8 for group driving, 5 of these 8 being in wood-working shops; 27 are constant speed and 56 variable speed motors. The total cost of these 83 motors was $20,275, or an average cost of $244.50, exclusive of mounting. The same motors could now probably be bought from 15 to 25 per cent. less. The average horsepower of these 83 motors is 12.05.

During the year 1904, the average horsepower taken by all machine tool motors was about 200 during working hours, but all the tools listed above were not in operation. The average power consumption at present is about 300 h.p., or about 30 per cent. of the horsepower rating of the motors. During the year 1904, the average power consumption of the machine tools was 17.3 per cent. of the output of power house; it was 38.71 per cent. of the total electric power; lighting was 24.9, heating motors 23.78 per cent. The electric power consumption of the machine tools including cranes and blast fan was subdivided as follows:

Variable speed tools	39.71%
Constant speed tools	26.80%
Blast fans	28.44%
Cranes	5.05%
	100.00%

The total cost of power for the machine tools, including the cranes, was $2,662.66, this does not include the maintenance of motors.

In addition to the shops being well equipped with motor-driven tools, there are at present in service seven cranes from 120 ton to 7½ ton capacity. Three more will be added shortly. The capacity of the power house for electric work is 600 k.w. full load rating, or 750 k.w. with 25 per cent. overload. There is space for one additional generator of 150 k.w. capacity.

The following few items are given concerning speeds of cutting. These are not given as maximum and are not special tests, but are every day practice, as previously stated.

P. & L. E. R. R. CO.—McKEES ROCKS SHOPS.

SAMPLE CUTTING SPEEDS.

No.	Machine Description.	Wt. Removed Lbs. per Min.	Speed Ft. per Min.	Material.	Remarks.
10	Lathe	2.63	106	Cast iron	
10	"	2.33	44	Steel	
16½	"	1.69	170	"	
13	"	3.43	43	"	
20	"	4.2	54	Wrought iron	
14	Wheel Lathe	6.3	13.2	Steel	
23	" "	5.3	15.5	"	
51	Planer	3.2	30	Cast steel	
52	"	18.3	29	Cast iron	
62	Shaper	2.03	120	Brass	60 strokes, min.
39	Drill	0.52	74.5	Wrought iron	1¼-in. drill
147	"	0.88	53.9	" "	1¼-in. drill
33	Boring Mill	1.1	59.5	Steel	

Railroad shops are in general repair shops, so the weight of metal removed is not at all remarkable, compared to many tests which have been reported. To show the excellent results obtained in the new shops the following figures may be noted. The shops were opened in February, 1904, but were not in full operation until some months later. It, of course, took some time to become used to new conditions, so that results for year 1905 would probably show a higher increase over year 1903.

Locomotives repaired	1903	64
" "	1904	145
Locomotives built	1903	None
" "	1904	10
New fireboxes	1903	5
" "	1904	21
Cost of labor	1903	$216,472
" " "	1904	$236,871
An increase of only 9.5%		
Credit for outside work	1903	$4,800
" " " "	1904	$61,516

The force of men is now 25 per cent. more than during 1903, but the output is very considerably greater. Formerly five to seven locomotives were overhauled per month, now from fourteen to twenty. Very much of the increase in number is due to the repairing of locomotives for other roads.—Erie, Lake Shore, Pennsylvania and Union R. R. The new shops are considered an excellent investment despite the heavy first cost, and it is estimated that they will have paid for themselves, including first cost and interest, in ten years or less.

DIES FOR FORGING MACHINES.

BY S. J. UREN.*

In a shop where orders for a large quantity of car and locomotive forgings come in daily, the first thing that enters the foreman's mind is how to get it done quickly, and I find by experience the best way is by the forging machine and bulldozer. It is surprising the large amount of forgings that can be turned out by one of these machines daily, and no well-equipped shop should be without them.

With our 4-in. Ajax forging machine we are turning out the following: Swing hangers for passenger car trucks, bolsters for all baggage and postal cars, crown bars for locomotive boilers, crow-feet for locomotive boilers, drawbar straps for baggage and freight cars, connecting rods for S. P. switch stands, slide plates for switches, and other forgings too numerous to mention.

In designing the dies for the different work that can be done on these machines the first thing to do is to figure out the amount of stock it takes to make the piece required, which will give you the length of die to use. In making swing hangers for passenger car trucks (Fig. 1) we use two pieces of iron ⅞ in. x 3 in. x 19 in. long. We lay them together, put them in a small oil furnace and in a very short time we have a welding heat about 10 ins. long on them. We take them to the machine, place them in the dies and press the lever down. The header enters the dies, the back-stop on the machine holds the iron from slipping back, and the head on the hanger is made. We then turn it around, put it in the same die a little higher up and press the lever down. The mandrel in the header-block enters the die, pushes the wings of the hanger apart, and the hanger is completed. We make from fifty to sixty of these hangers per day, so it does not take long for a machine of this kind to pay for itself.

*From a paper read before the Pacific Coast Railway Club.

Care must be taken in setting dies in the machine and all bolts must be tightened before starting. Fig. 1 shows the dies used for making these hangers, the length of headers and size of dies required. The die seat is 21 ins. long when the dies are closed and the header-block is up to the end of the stroke. The space between the header-block and the dies is 4⅛ ins. When shorter dies are used the punch or header heat on the end of the bar, place it in the machine and press the lever down. The dies close, the header comes up, hits the end of the bar, welds and presses it into shape, and we have one end of the bolster completed. Reverse the end, go through the same operation, and we have a bolster completed in quicker time than it takes to explain it. I find by testing this class of work by the steam hammer process

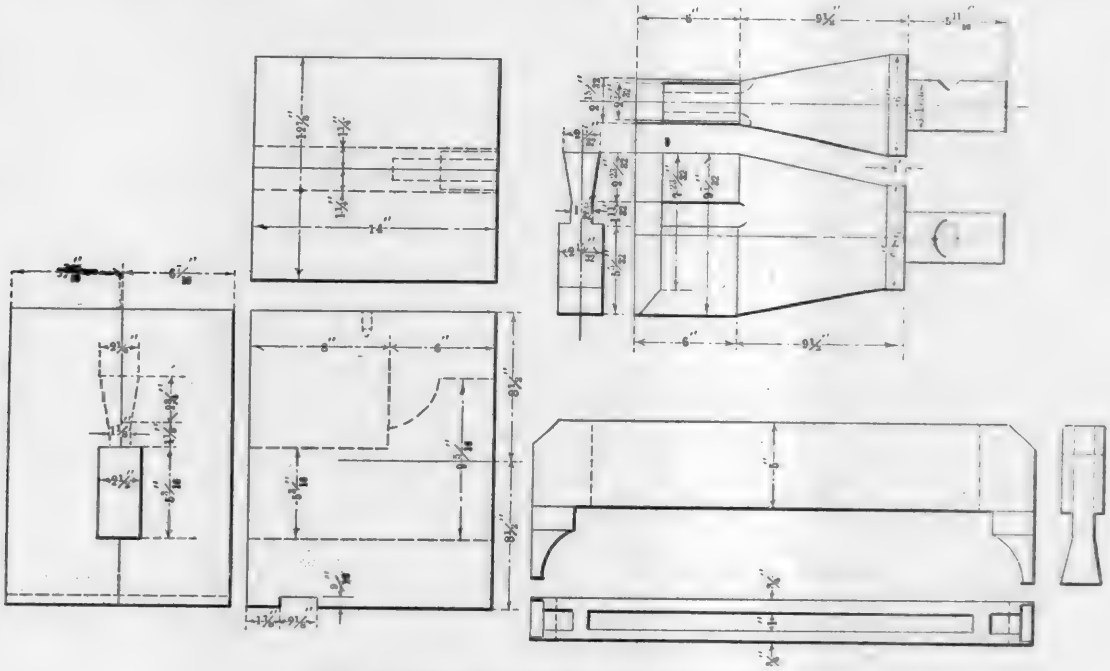


FIG. 2—DIES AND HEADERS FOR CROWN BARS.

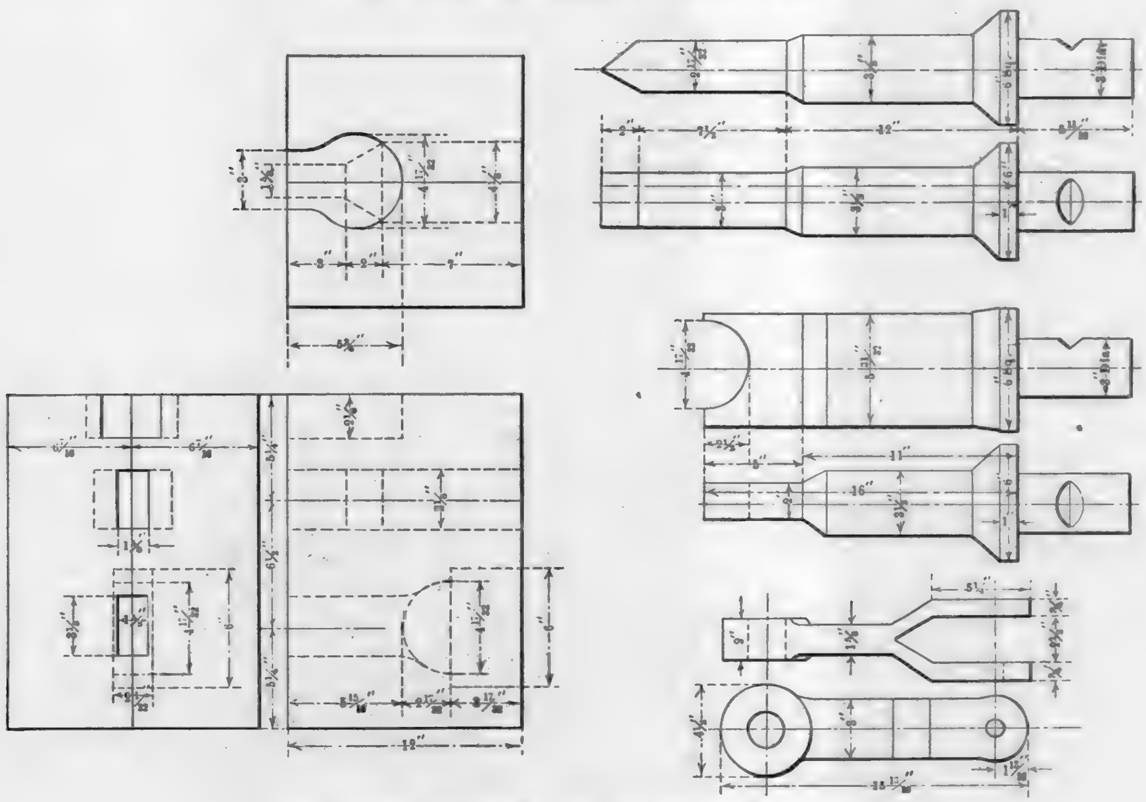


FIG. 1—DIES AND HEADERS FOR MAKING SWING HANGERS.

must be increased in length in the same proportion. As the length of the dies is decreased when headers, punches or mandrels enter the dies the distance they go into the dies must also be increased.

In making the bolsters for the tea and silk cars recently built in the Sacramento shops we take our 1 x 12 in. bars, cut them off 2 ins. longer than the length required, lay a piece of 1 x 5 x 12 in. on the end (this allows 1 in. on each end of the bar for upsetting and welding), get a nice white

that it will stand a better test than similar work done by hand. These ends are put on at the rate of twenty to twenty-five per day.

Crown bars (Fig. 2) for locomotive boilers are made in a similar manner—by laying a piece of 1⅛ x 3 x 9 in. between two pieces of ¾ x 5 in. by any length required, welding and pressing into shape by one operation.

We have a great many target connecting rods (Fig. 3) for S. P. switch stands to make in the Sacramento shops, and

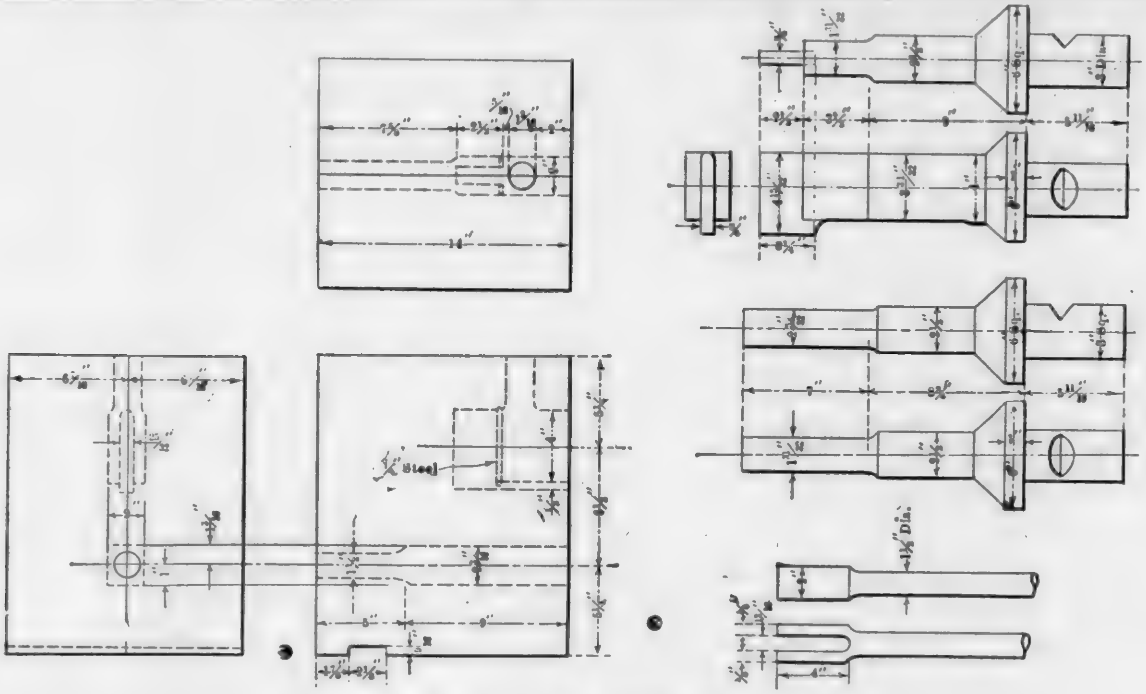
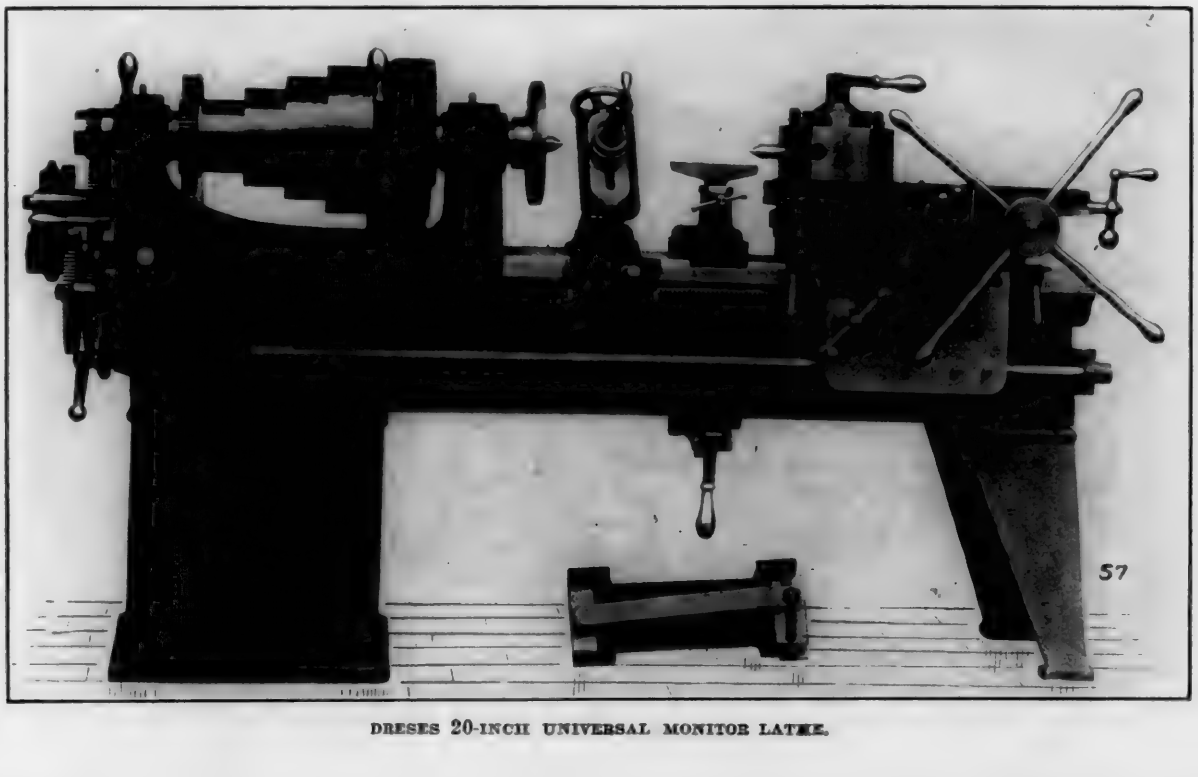


FIG. 3—DIES AND HEADERS FOR TARGET CONNECTING RODS.

this is a simple job made on the machine. We take our bar of 1½ in. round iron the required length, get a white heat on end of it about 11 or 12 ins. long, place it in the lower portion of the die and press the lever. The plunger comes up and makes an end on the bar 2⅛ x 2 x 4½ ins. long. We then take it out of the lower portion of the die, place it in the upper portion in a vertical position, and the punch comes up and punches the jaw. Now, we have the jaw on the rod completed. We then take the rod to a 3-in. Ajax forging machine that we have close by for the upsetting of the other end. This takes but a very short time, and we have a target connecting rod completed without a weld. The idea in taking these rods from one machine to the other is to save time of changing and setting dies.

The bulldozer, as well as the forging machine, is a machine that should be in every blacksmith shop where there is much bending and forming to be done, such as drawbar straps for passenger or freight cars, arch-bars for freight or tender trucks, side-sill steps, uncoupling levers, carry irons, corner irons, links and a large amount of other wrought iron work that is used on cars and locomotives.

The face of the machine which is constantly in use in the Sacramento blacksmith shop is fourteen inches high, 5 ft. 4 ins. wide, and has two grooves running the width of the face cut out the same as the grooves in the bed of a planer. We have two rollers, simply constructed, that we fasten to the face of the machine with the bolts slipped in the grooves. Consequently we can shift these rollers, to bend straps, from ½ in. width of opening up to 5 ft. When any material has to be bent at right angles we slip one of the rollers out. The plate on the back-stop of the machine is constructed similarly to the face-plate, and we fasten all dies, formers and mandrels to this. The material is held in the formers or mandrels, before bending, by a hinged clamp made for the purpose. The bulldozer we use is a No. 7, and I think, is large enough for all railroad purposes.



DRESES 20-INCH UNIVERSAL MONITOR LATHE.

20-INCH UNIVERSAL MONITOR LATHE.

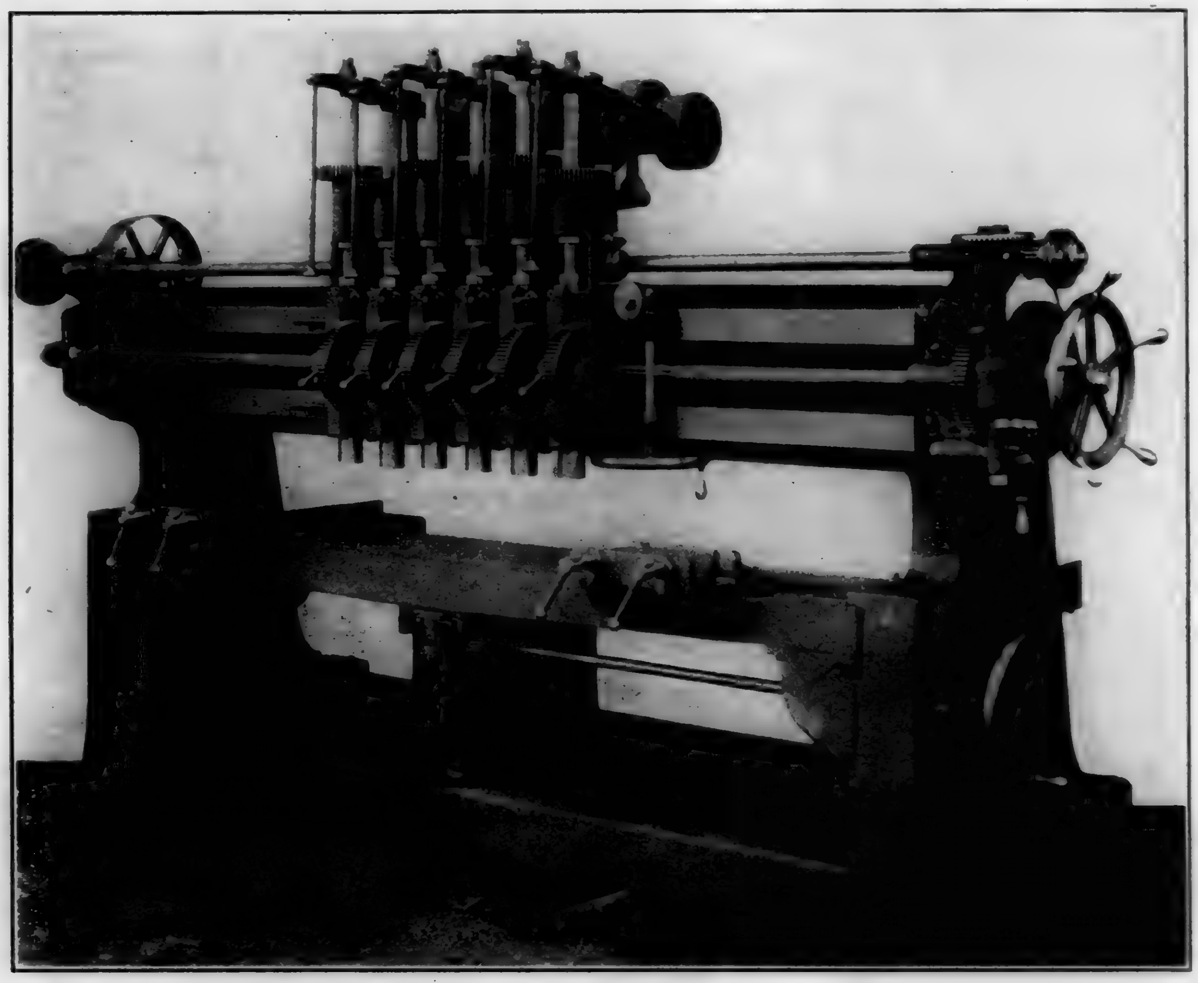
The universal monitor lathe, illustrated herewith, is designed for general brass turning and similar work of special and heavy character, and with the object of economically performing manufacturing operations without special tools. The turret carriage is provided with an automatic feed, similar to that of an ordinary engine lathe, and the four coarsest feeds are 8, 11½, 14 and 18 per in., conforming with the standard pipe threads. This arrangement not only avoids the stripping of the threads in large tapping, but inside and outside straight and taper threads may be cut by a turret tool without a tap or die. There are 12 changes of feed in all, the other eight being multiples by 3 and 6 of the four coarse feeds. Four changes of feed can be made instantly by a handle, located below the headstock, and the reverse is made by a knob in front of the apron.

Interposed between the lower and upper part of the turret carriage is a double dove-tailed plate, to the lower side of which is swiveled-connected, a shoe which slides on the bar of the taper attachment shown below the bed. The frame of this attachment slides between the V's of the bed and the bolt clamping, the guiding bar also holds it in any position longitudinally. The whole attachment can readily be removed when not in use. The upper part of the intermediate dovetail plate has a screw with a ball crank handle for cross feeding by hand, and screw clamping stops are provided for setting the turret holes in line with the spindle.

The turret carrying slide is provided with a pilot wheel for rapid longitudinal movement and a screw for finer adjusting. The turret revolves on a stem with adjustment for wear, and the locking pin withdraws at the return movement of the top slide, making it semi-automatic. The machine is equipped with the ordinary chasing bar and the follower holder is yielding for taper work. Right and left hand threads may be cut without changing the leader. The headstock is friction back-geared, and has a four-step cone pulley with an extra large belt contact. The spindle has a 1-13/16-in. hole through it, and a wire feed can be easily applied. The cabinet support under the head is provided with tool shelves, and the tail leg is attached in a hinge manner to form a three-point support. This machine weighs about 2,900 lbs., and is made by the Dreses Machine Tool Company, Cincinnati, O.

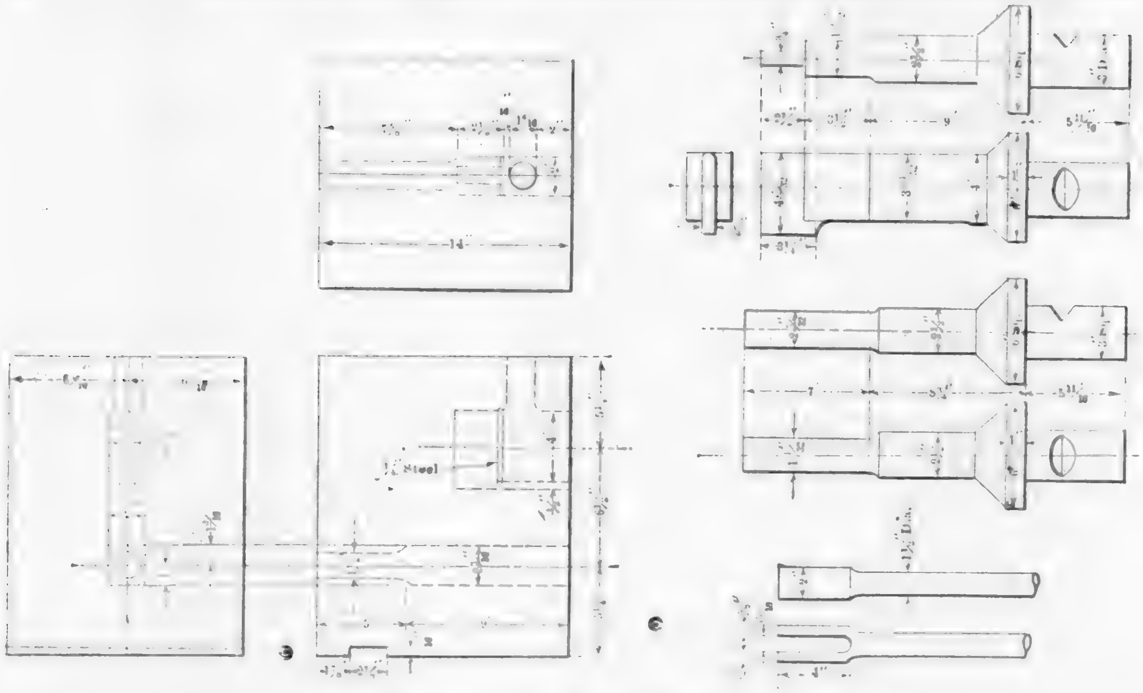
MUD RING DRILL.

Although the mud ring drill, shown in the accompanying illustration was specially designed for that purpose, it is equally well adapted for all operations of multiple drill work. The heads instead of sliding on an auxiliary rail, as in the ordinary construction, adjust directly on the main rail, which enables them to be spread to any desired center distance each head being provided with an independent adjustment. For mud rings or similar work where it is desirable that the heads should adjust collectively the heads are clamped together by means of two quick-acting nuts, which fix the center distance between spindles at 7½, 8, 8½ or 9 ins. as may be required. A dial on the worm-wheel at the upper corner of the right hand head shows the distance through which the heads are moved to the right and left.



BICKFORD MUD RING DRILL.

The speed and feed changes are obtained by means of change gears, which are held in position by spring plungers, thus enabling the operator to change quickly from one speed or feed to another without lessening the available power of the machine. A dial on the large worm-wheel at the right shows where to set the dog to trip the feed at any desired depth. The spindles are 1 13/16 ins. in diameter, have a vertical movement of 12 ins. and work to a maximum center distance of 26¼ ins. The table has a transverse movement



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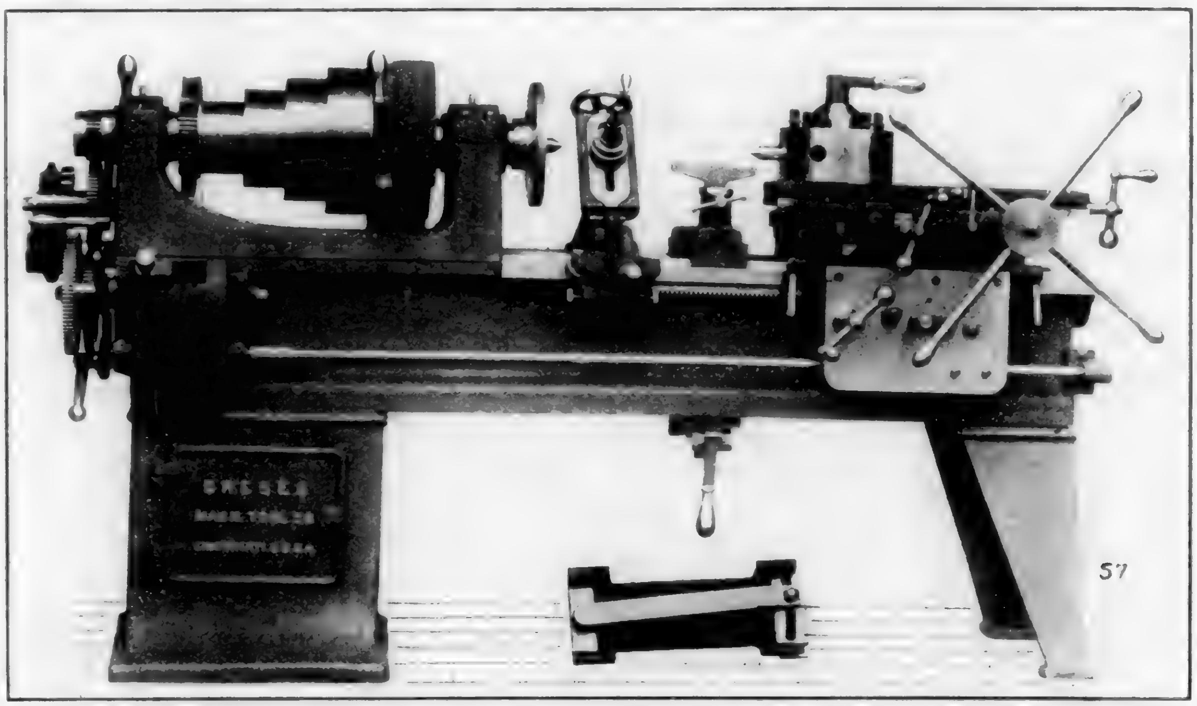

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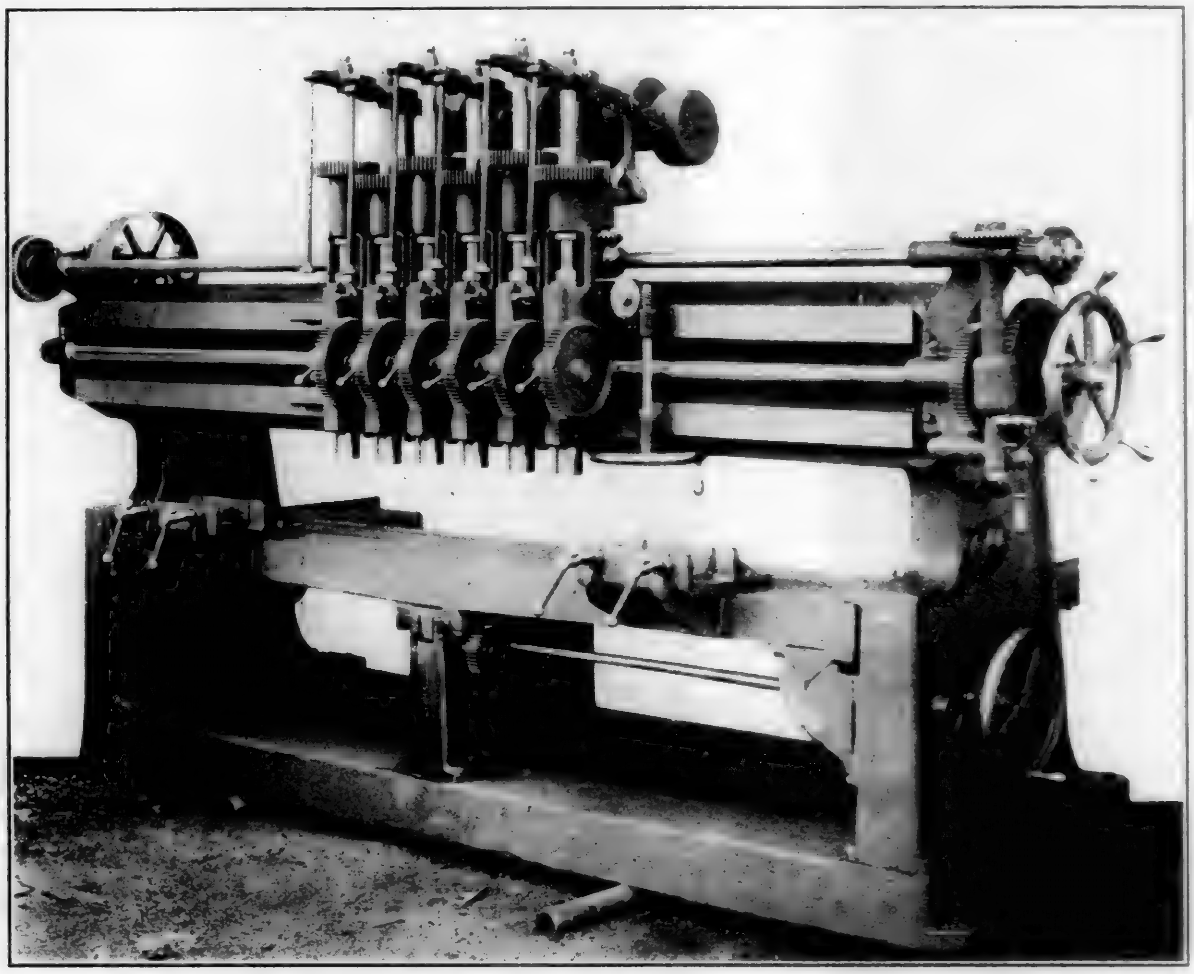

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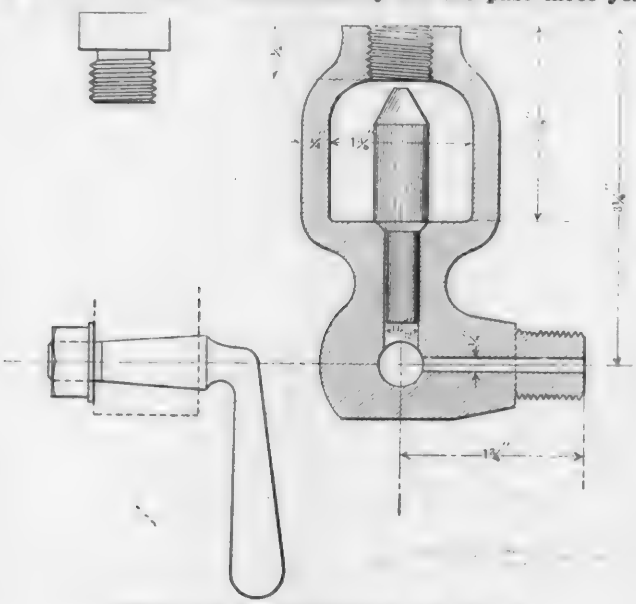
of 24 ins. and receives between housings with a 12 ft. rail, work up to 10 ft. 6 ins. Driven by a constant speed pulley the power is never less than that obtainable from a 5-in. double belt, running at 1,696 ft. per minute. The net weight of this machine, which is made by the Bickford Drill & Tool Company, Cincinnati, Ohio, is 17,500 lbs.

LUBRICATOR FOR LOCOMOTIVE AIR PUMPS.

Considerable trouble has been experienced due to wear of the air piston packing rings and the air cylinders of locomotive air pumps, because of insufficient lubrication. The accompanying drawing shows a lubricator which has been in use on the Northern Pacific Railway for the past three years



LUBRICATOR FOR LOCOMOTIVE AIR PUMPS.

with excellent results. A hole is tapped for it midway between the two ends of the air cylinder. The plunger has 1/32 in. lift, and as air is compressed the valve is raised off its seat, and when the air is drawn into cylinder the valve is seated, and thus at each stroke of the pump a small amount of oil is fed to the cylinder. The body of the cup is of cast iron, while the plunger and cap screw are of steel. The lubricator holds one cu. in. of oil, enough for a round trip over a division of 150 miles. The plug valve in the passage between the oil reservoir and the pump, is a recent improvement, and by its use it is unnecessary to stop the pump working whilst the lubricator is being filled. This lubricator was designed and patented by Mr. A. W. Wheatley, now superintendent of shops at Moline, of the Rock Island System. By its adoption in a mountainous country, pumps have run as long as ten months on one set of air cylinder packing rings, whereas, prior to its use the packing rings never gave more than one month's service.

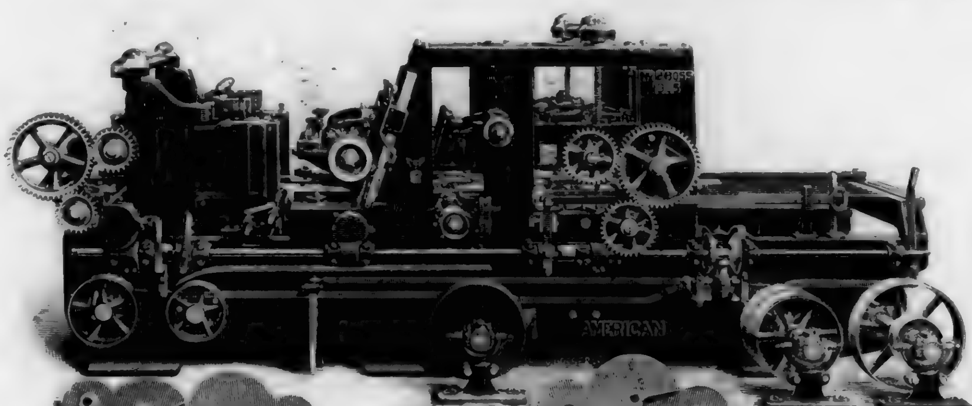
1906 M. C. B. AND M. M. CONVENTIONS.

At a meeting of the joint executive committees of the Master Car Builders' and American Railway Master Mechanics' Associations at the Hotel Manhattan, New York City, December 11, it was decided to hold the next annual conventions of these Associations at Atlantic City, N. J. The Master Car Builders' Association will meet June 13 to 15 inclusive, and the American Railway Master Mechanics' Association, June 18 to 20 inclusive. A number of hotels, members of an association in Atlantic City, agreed to reserve in all 2,040 rooms, with 825 private bath rooms. The meetings will be held on the Iron Pier, which is but a few minutes' walk from most of the hotels. The exhibits will be placed on the east side of the Iron Pier. Applications for space should be made to L. B. Sherman, Secretary of the Supplymen's Association, Old Colony Building, Chicago, Ill.

AMERICAN BOSS TIMBER SIZER.

The engravings show the front view of the new American Boss timber sizer with six rolls and the rear view of a similar machine with eight rolls. These machines are very heavy and powerful, but the construction is simple and they are very easily handled. All parts which require adjustment are arranged so that they may be quickly and conveniently adjusted with a minimum amount of exertion on the part of the operator. These machines are adapted for a very wide range of work. The six roll machines are made in sizes to work 20 or 30 ins. wide by 12 or 14 ins. thick, while the eight roll machines work 20 or 30 by 16, 18 or 20 ins. thick. The sides of the frame are heavily ribbed and the cross girts are planed to a seat and firmly bolted. The construction throughout is very substantial and rigid.

The bottom cylinder cuts first, and it can be quickly drawn out for changing or sharpening the knives. The front lower cylinder bar, together with the lower feed rolls, is so arranged that by the use of a hand wheel on the side of the machine the cut of the under head may be changed as desired, while the machine is running, without altering the finished thickness of the material or disturbing the cutter head, and any desired amount of stock can be removed up to ¾ of an in. The top and bottom cylinders are made of hammered crucible steel forgings, slotted on four sides, and have

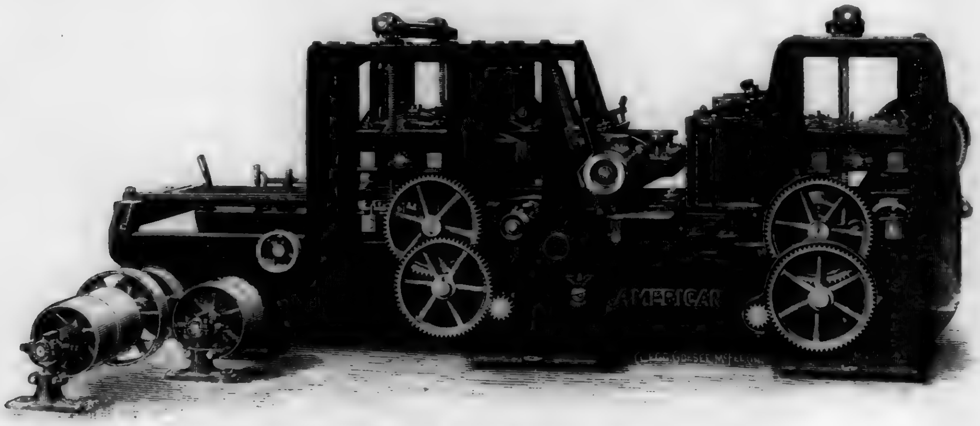


AMERICAN BOSS TIMBER SIZER, SIX ROLLS, FRONT VIEW.

extended lip chip breakers. The journals are of large diameter and run in long self-oiling boxes. The feed is very powerful, consisting of 10-in. rolls, geared at both ends, well geared back to the two pinions that divide the labor. On the 30-in. machine the first two top rolls are divided, while on the 20-in machine all rolls are solid, and all top rolls are independently weighted and rise and fall parallel to the bottom rolls.

The side spindles and jointer heads are of hammered crucible steel. The jointer heads can be quickly removed by the removal of the top boxes, when matcher or other style of heads may be substituted. The cylinder and side spindle boxes are all large, contain self-oiling devices, and each pair is heavily yoked together to insure their perfect alignment. The top cylinder yoke is supported on substantial uprights, and, when set to desired thickness may be firmly clamped in

position by means of a lever at the front side of the machine. The lower cylinder yoke is held in planed ways, and has independent adjustment and is firmly clamped when back in position. The side yokes or boxes are supported on three



AMERICAN BOSS TIMBER SIZER, EIGHT ROLLS. REAR VIEW.

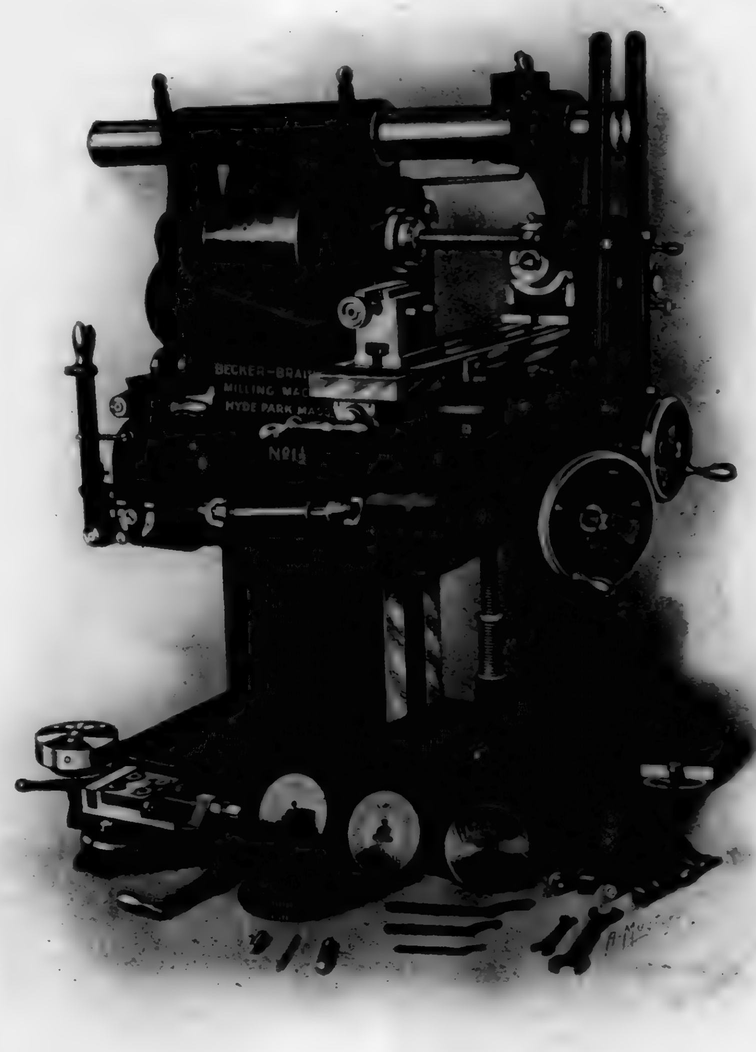
heavy cross bars and by means of attached levers which operate wedges, these boxes are clamped firmly in position. Pressure bars for the lower cylinder can be adjusted to allow the knife to extend ¾ in. beyond the lip of the cylinder. The pressure bars over the lower cylinder are hung on separate yokes and rise and fall vertically in pockets. The pressure is obtained by weights. They are carried in the same frame that carries the top cylinder and chip breakers; and, therefore, do not have to be adjusted independently. The chip breaker for the top cylinder is in four sections, and so constructed as to allow of an independent yield of 1¾ in. on each section, and the whole chip breaker will yield further by swinging up on the arms. The chip breakers for the side heads are made up of narrow sections, interchangeable and adjustable, held in a swinging frame in the shape of a hood. This is pivoted, and when the chip breaker weight is unhooked, may be swung clear of the head to admit of free access to the cutters. Exhaust pipe can be readily attached. The frame or slide holding the lower cylinder yoke is so formed as to make a complete hood for this head, to which pipe connections can be made.

The top feed rolls and top cylinder can be almost instantly adjusted by the use of a power hoist, which can be operated from the operator's position at the end or side of the machine. It is very effective, being belted from the main countershaft, and is available whether the feed is on or off. The side rods that convey the power to the screws which raise and lower the upper rolls are in three sections, coupled by clutches, which may be adjusted independently so that the rolls before the cut may be raised and lowered by power independently, to take care of stock of unusual variations in thickness, or the rolls and the top head may be raised without disturbing the position of the rear rolls, or the outfeeding rolls may be raised when a light cut is being taken to avoid marring the lumber.

These machines are made by the American Wood Working Machinery Company, and require about 40 h.p. for driving.

NEW UNIVERSAL MILLING MACHINE.

The Becker-Brainard universal milling machine, illustrated herewith, embodies several important improvements, among them the positive gear feed drive and the change feed mechanism, by which any one of 20 changes of feed can be obtained without stopping the machine; also a new clutch mechanism in connection with the hand wheels, a box type of knee and a telescopic elevating screw. The spindle is made of hammered crucible steel, has a ⅜-in. hole through its entire length and runs in self-centering bronze boxes, arranged to compensate for wear. It has a slot across the end to engage a clutch collar on the arbor and is threaded to take a chuck, a threaded collar covering the screw when not in use. The spindle is connected with the change feed mechanism by three spur gears and is back-geared in 5 to 1 ratio. The gears are protected by guards.



BECKER-BRAINARD UNIVERSAL MILLING MACHINE.

Sixteen spindle speeds ranging from 15 to 355 r.p.m. are provided for. The change feed mechanism is conveniently located on the back of the column and any one of 20 feeds, ranging from 0.002 to 0.125 ins. per revolution of the spindle, may instantly be obtained while the machine is running, by moving the vertical lever at the side of the box. The

table has a working surface of 37¼ by 7 ins. and has an automatic longitudinal (24 ins.), and a cross feed (8 ins.) in either direction. The table is centrally driven and feeds freely at any angle up to 45 degs. either side of the center line. The feed may be reversed from the front of the machine.

The hand wheels are provided with a clutch arrangement enclosed in a hub. One of these wheels controls the vertical movement of the knee and the other the table cross feed. When either the knee or carriage have been set to the required position the clutch may instantly be disengaged by pressing the knob on the front of the hand wheel, thus preventing any accidental change from their fixed position, and, also, preventing them from revolving when the automatic feeds are thrown in. The dials for indicating the vertical, transverse and longitudinal movements of the platen are adjustable and graduated to read to thousandths of an inch, and may be set at any position with a set screw.

The arm is made of steel, has a horizontal adjustment and the arbor support may be removed so that any of the attachments can be placed in position without the necessity of removing the arm. The dividing head can be set at any angle from 10 degs. below the horizontal to 5 degs. beyond the perpendicular. It is arranged for plain and differential indexing of all numbers to 360. By means of 10 change gears nearly any spiral from 1.25 to 68.57 ins. may be cut. The knee has a vertical adjustment of 17 ins. The net weight of this machine, which is known as No. 1½, and is made by the Becker-Brainard Milling Machine Company, of Hyde Park, Mass., is 2,500 lbs.

BOOKS.

Pocket-book of Mechanical Engineering. By Charles M. Sames. 168 pages, 38 illustrations. Published by Charles M. Sames, 448 Jersey Avenue, Jersey City, N. J., 1905. Bound in flexible leather. Price, $1.50.

The author's aim has been to compact the greater part of the reference information usually required by mechanical engineers and students, into a volume which can be carried in a pocket without inconvenience, and he has been remarkably successful. The book measures 4 by 6⅝ ins. and is only about 5/16 in. thick. It is replete with tables, data, formulas, theory and examples conveniently and compactly arranged, and includes the very latest obtainable data. The main sub-divisions of the book are as follows: mathematics, chemical data, materials; the strength of materials, structures and machine parts; energy and the transmission of power; heat and the steam engine; hydraulics and hydraulic machinery; shop data and electrotechnics. A good index has been provided and in addition to this the subject matter is so classified that any subject may easily be referred to.

Poor's Manual, 1905. Thirty-eighth annual number. Published by Poor's Railroad Manual Company, 68 William Street, New York. Price, $10.00.

This volume, issued in November, contains more than 1,600 pages devoted to detailed statements of the operations and conditions of every railroad company, steam and electric, in the United States and Canada and the leading railroads in Mexico. Also similar information concerning miscellaneous industrial corporations and a department devoted to statements showing the finances and resources of the United States, the several states, and the chief counties, cities and towns in this country, together with detailed descriptions of the funded debts of each. In addition it contains twenty-four colored plate State and group maps and 48 maps of leading railroads. The statistics show that in the United States at the close of 1904 there were 212,349 miles of railroad in operation, or an increase of 5,414 miles over the preceding year. The number of locomotives was 48,658, or 4,120 more than at the end of the preceding year, while the number of revenue earning cars was 1,770,884, or an increase of 41,481 in one year.

Gas, Gasoline and Oil Engines, including Gas Producer Plants. By Gardner D. Hiscox. Fifteenth edition; 450 pages; 351 illustrations. Published by the Norman W. Henley Publishing Company, 132 Nassau Street, New York City, 1906. Price, $2.50 net.

The many recent improvements in the design of internal combustion engines, and the rapid development of the producer gas industry have been such that it was necessary to entirely revise and rewrite the previous edition of this work, in order to bring it up-to-date, and this volume is practically a new book from cover to cover. It considers gas, gasoline, kerosene and crude petroleum oil engines and also producer gas plants. It fully describes and illustrates the theory, design, construction and management of the explosive motor for stationary, marine and vehicle motor power. An important addition is the regulations of the National Board of Underwriters in regard to the installation and operation of gas producers. The list of United States patents of explosive motors has been brought up-to-date, and a list of the manaufacturers of these engines in the United States and Canada has been added. This volume forms a very valuable and important contribution, and should be in the hands of all those who are interested in this subject.

H. H. VAUGHAN.

Mr. H. H. Vaughan, superintendent of motive power of the Canadian Pacific Railway has been advanced with the title of assistant to the vice-president of that road. It is understood that this new office constitutes jurisdiction over motive power, rolling stock, stores, fuel and all electrical and mechanical matters. This is a distinct recognition of the importance of placing motive power and rolling stock matters in the hands of an executive who is not a department official.

Mr. Vaughan was born in England, graduated from Kings College, London, served an apprenticeship at the works of Naysmith, Wilson & Company, at Patricroft, Eng., and after that worked for a short time as a machinist at the Gorton Shops of the Manchester, Sheffield and Lincolnshire Railway, and at the Nine Elms works of the London and South Western Railway. In 1891 he came to the United States and entered the shops of the Great Northern as machinist. He served as draftsman from September, 1891, to May, 1894, when he was made assistant engineer of tests. In May, 1895, he became mechanical engineer, and while in this position developed marked ability in designing a number of important devices, among which is the present engineer's valve of the New York Air Brake Company. In February, 1898, he was appointed mechanical engineer of the Philadelphia & Reading Railroad at Reading, Pa., and two years later was placed in charge of the management of shops and mechanical engineering department of the Q. & C. Company in Chicago, where he had valuable manufacturing and commercial experience. In March, 1902, he was called to the Lake Shore & Michigan Southern Railroad as assistant superintendent of motive power, and in February, 1904, was appointed superintendent of motive power of the Canadian Pacific. On this road Mr. Vaughan has had the difficult task of organizing the operations of the very large new railroad shops, which of itself is a sufficient undertaking for the short time he has been there. This, however, is only a part of the record which he has made in the short time he has been at Montreal, which has now placed him in a leading position in the motive power world, and one in which he has a most promising opportunity to show the real importance and the great possibilities for improvement in motive power methods. Mr. Vaughan is a young man for his present responsibilities, and it is important to note that he came to this country fourteen years ago a perfect stranger and began his services as a machinist.

The action of the Canadian Pacific in making this appointment is significant of the appreciation of the magnitude of the motive power problem and its possibilities, which is an exceedingly hopeful sign of a radical change of opinion, which should lead to a revolution in the methods of handling the locomotive on railroads. The American motive power matters will never be handled as they should be until the highest officials realize the importance of placing the responsibilities in the hands of an executive and not a department officer.

We congratulate the Canadian Pacific upon their choice, and also Mr. Vaughan upon his well-merited promotion, and extend our best wishes for his future success.

PERSONALS.

Mr. F. M. Fryburg has been appointed master mechanic of the Montana Central at Great Falls, Mont., succeeding Mr. C. M. Prescott, resigned.

Mr. Frank Zink has been appointed acting superintendent of motive power of the Santa Fe Central at Estancia, N. Mex., to succeed Mr. G. H. Shone.

Mr. George Tilton has been appointed superintendent of shops of the Mexican Central at Aguascalientes, Mex., to succeed Mr. H. V. Ridgeway, resigned.

Mr. W. J. Knox, chief draftsman of the Buffalo, Rochester & Pittsburg Railway, at DuBois, Pa., has been appointed mechanical engineer of that road.

Mr. A. B. Ford, traveling engineer of the Great Northern at Great Falls, Mont., has been appointed master mechanic at Minot, N. D., succeeding Mr. C. T. Walters.

Mr. George B. Longstreth, heretofore master mechanic of the Tennessee Central at Nashville, Tenn., has been appointed master mechanic of the Nashville Terminal Company.

Mr. C. T. Walters, master mechanic of the Great Northern at Minot, N. D., has been appointed master mechanic at Havre, Mont., succeeding Mr. F. M. Fryburg, resigned.

Mr. H. P. Durham has been appointed superintendent of motive power and machinery of the Tehuantepec National, at Rincon Antonio, Mexico, succeeding Mr. Louis Greaven.

Mr. W. W. Lowell, master mechanic of the Chicago, Burlington & Quincy at Brookfield, Mo., has been transferred to St. Joseph, Mo., to succeed Mr. Jacob Kastlin, resigned.

Mr. W. C. Ennis, master mechanic of the Delaware & Hudson at Oneonta, N. Y., has been appointed superintendent of car shops and repair work, with headquarters at Carbondale, Pa.

Mr. G. S. Edmonds, mechanical engineer of the Delaware & Hudson, has been appointed master mechanic of the Susquehanna & Pennsylvania division, with office at Oneonta, N. Y.

Mr. L. R. Johnson has been appointed assistant superintendent of motive power of the Canadian Pacific in charge of the Angus shops, and Mr. J. B. Elliott has been appointed general master mechanic of the lines east of Fort William.

Mr. C. S. Bricker has been appointed master mechanic of the Sheridan Division of the Burlington lines west of the Missouri River, with headquarters at Sheridan, Wyo., vice Mr. C. J. Saberhagen, resigned.

Mr. F. E. Kennedy has been appointed master mechanic of the McCook division of the Burlington Lines West of the Missouri, with headquarters at McCook, Neb., to succeed Mr. R. B. Archibald, resigned.

Mr. J. H. Bannerman, formerly superintendent of motive power of the Tennessee Central, has accepted a position with the W. J. Oliver Manufacturing Company of Knoxville, Tenn., as mechanical superintendent.

Mr. S. B. Gorbutt has resigned from the position of mechanical engineer on the Colorado Midland Railway, at Colorado City, to accept the position of mechanical superintendent of the Portland Cement Company, at Portland, Colo.

Mr. H. C. Woolbridge, heretofore general foreman of the Delaware, Lackawanna & Western, at Elmira, N. Y., has been appointed master mechanic of the Buffalo and Rochester divisions of the Buffalo, Rochester & Pittsburg, with office at East Salamanca, N. Y.

Mr. William Donald has been appointed master mechanic of the Rio Grande Western at Salt Lake City, Utah, to succeed Mr. John Hickey, who has resigned owing to ill health.

The position of assistant superintendent of motive power on the Burlington lines west of the Missouri River has been abolished, and Mr. E. W. Fitt has been appointed master mechanic of the Alliance and Sterling divisions, with headquarters at Alliance, Neb., vice Mr. F. J. Kraemer, assigned to other duties.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER

LOCOMOTIVE BLOW-OFF VALVES.—The Lunkenheimer Company, Cincinnati, O., are sending out a circular which is devoted to their locomotive blow-off valves.

STEEL CRANE MOTORS.—Bulletin No. 32 from the Northern Electrical & Manufacturing Company, Madison, Wis., considers in detail the construction of the Northern steel crane motors and their application to cranes.

PNEUMATIC APPLIANCES.—Special circular No. 55 from the Chicago Pneumatic Tool Company, Fisher Building, Chicago, is devoted entirely to a description of pneumatic appliances for foundry and concrete block work.

COUPLING BOLT FORCER.—The Watson-Stillman Company, 46 Dey street, New York City, have sent out sheets Nos. 325, 326 and 329, which illustrate and describe the different varieties of this tool, which they manufacture.

SINGLE PHASE RAILWAY SYSTEMS.—Circular No. 1,127 from the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., is entirely devoted to control apparatus, trolleys and line construction for single phase railway systems.

VAPOR SYSTEM OF CAR HEATING.—Special circular No. 4 from the Chicago Car Heating Company, Railway Exchange, Chicago, describes the vapor system for car heating and pointedly calls attention to its advantages over other systems. Two large colored plates are introduced, which clearly show its construction, operation and advantages.

TRACK DRILLS AND DRILL BITS.—The Buda Foundry & Manufacturing Company, Railway Exchange, Chicago, are sending out a catalog which is devoted to a description of the various improvements which have been made in track drills and attachments. Considerable space is devoted to the Rich flat drill bit, which is made of high-speed steel.

MOTORS FOR HOISTING SERVICE.—Leaflet No. 148 from the Northern Electrical Manufacturing Company, Madison, Wis., shows several applications of the Northern box type motor to different types of hoists. These motors are specially designed for this service; they are dust and weather proof and have exceptionally strong shafts and liberal bearings.

ELECTRICAL APPARATUS.—The following bulletins have been received from the General Electric Company, Schenectady, N. Y.. No. 4,423, alternating current (1,150 and 2,300 volt) switchboard panels; No. 4,425, 4,500 volt oil break switches; No. 4,426, C1-B slow and moderate speed belt-driven generators; No. 4,427, Type MC governor for electrically driven air compressors.

THE PENNSYLVANIA SPECIAL.—The Pennsylvania Special, a two-step march by Bandmaster F. N. Innes, is being distributed in the interest of their 18-hour train between Chicago and New York. The music is dedicated to Samuel Moody, general passenger agent, and will be sent upon receipt of four cents, to cover postage, by the Pennsylvania Lines' Advertising Bureau, 702 Union Station, Pittsburg, Pa.

PNEUMATIC TOOLS AND APPLIANCES.—A handsome 6 by 9, 192 page general catalog has been received from the Chicago Pneumatic Tool Company, Chicago. It covers their entire line of pneumatic tools and appliances, together with a complete price list of the repair parts used on all tools in general use, including the "Boyer" and "Keller" products. This catalogue is ready for distribution and copies will be supplied, to those who are interested, upon application to the Chicago office.

BRAKE BEAMS.—A handsome catalog has been received from the Buffalo Brake Beam Company, Buffalo, N. Y. It is devoted to an illustrated description of the various beams, fulcrums, wheel guards, chain clips and safety hangers made by them.

STEAM ENGINE INDICATORS.—A folder from the American Steam Gauge & Valve Manufacturing Company, Boston, Mass., considers the several important advantages of the American-Thompson improved indicator with the new detent motion and the American ideal reducing wheel.

HOISTING AND CONVEYING APPLIANCES.—A handsome 200 page 12 by 9 catalog has been received from the Brown Hoisting Machinery Company, Cleveland, O. It is devoted to their hoisting and conveying appliances and contains a large number of full page half-tone views, showing various applications of apparatus designed and erected by them. These include cranes and conveying apparatus of all kinds. Among the applications of special interest to railroads are the bridge tramways for unloading coal and ore, the "Brownhoist"-"Fast Plants," car-dumping machines, locomotive coaling stations and locomotive cranes.

WOOD WORKING MACHINERY.—A very handsome catalog has been received from the American Wood Working Machinery Company, which shows a complete line of machinery for general use in planing mills, sash, door and blind, box, furniture, cabinet, car, agricultural implement, pattern and general wood-working shops. The illustrations of the various machines are large and the details are very clearly shown. The descriptions of the tools are complete and are so arranged that the information concerning any part can quickly be found. This is one of the best arranged and handsomest catalogs which we have ever received. It contains 320 pages, 9 by 12, and is cloth bound. The cover is tan colored and the lettering is done in black and gold.

MOTOR CARS FOR RAILROAD WORK.—Catalog No. 101A from Fairbanks, Morse & Company, Chicago, Ill., describes the various types of Sheffield gasoline inspection and section motor cars and considers the advantages and savings due to their use. We are informed that Mr. George H. Webb, chief engineer of the Michigan Central Railroad, made an inspection trip over that system on a No. 16 car last summer. The distance traveled was 4,347 miles and the total amount of gasoline used was 231 gallons, or an average of 19.7 miles per gallon. The total cost per mile, including lubricator oil, battery cells and everything excepting the wages of the man in charge, was nine-tenths of a cent. The car demonstrated its ability to attain a high rate of speed and maintain it on long runs.

COLE 4-CYLINDER BALANCED COMPOUND LOCOMOTIVE.—A very attractive thirty-six page pamphlet, with this title, has just been issued by the American Locomotive Company. The reasons for recommending this form of construction to meet American conditions are outlined, and locomotives of this type which have been applied to the New York Central, Erie and Pennsylvania Railroads are illustrated and described. A brief statement of the performance of the New York Central locomotive No. 3,000 on the testing plant at St. Louis is given, and line drawings showing elevations and sections of this locomotive and the construction of the frames, cylinders, crank axles and valves are presented. Line drawings are also introduced showing the application of the 4-cylinder balanced compounding to different types of freight and passenger locomotives. The pamphlet concludes with a number of comments from the technical press concerning this type of locomotive.

STURTEVANT PUBLICATIONS.—The B. F. Sturtevant Company, Boston, Mass., will hereafter issue most of its publications periodically under the title "Sturtevant Engineering Series." Each individual bulletin will treat of some particular product or its application. The series will also include reprints of pertinent articles or technical papers. All publications will be issued in uniform style and size suitable for binding consecutively or in allied groups. Bulletin No. 125, the first of this series, has just been published. It describes in detail the line of automatic vertical engines manufactured by the Sturtevant Company. These range from 5 by 5 ins. to 12 by 10 ins., are entirely enclosed and all bearings are provided with positive forced lubrication under 15 lbs. pressure. These engines, primarily designed to meet the exacting requirments of dynamo driving, are capable of continuous operation without skilled attention and represent the highest standard of material, workmanship and efficiency.

HORIZONTAL SLAB MILLING MACHINES.—Catalog No. 42 from the Newton Machine Tool Works, Philadelphia, Pa., considers their latest design of planer type milling machines; notable among these is the type with the auxiliary verticle spindle, which was described on page 381 of our October issue. An interesting illustration shows the method used in one of the large railroad repair shops for milling locomotive driving box shoes, and another illustration shows one of the latest improved machines milling the flutes in locomotive side rods.

NOTES.

FALLS HOLLOW STAYBOLT COMPANY.—This company of Cuyahoga Falls, O., announce that Falls Hollow iron has been specified for a number of locomotives recently ordered from the Baldwin Locomotive Works by the Seoul Fusan Railroad of Japan.

THE FARLOW DRAFT GEAR COMPANY.—This company, of Chicago, announces that they have recently received orders for 1,200 Farlow draft gears from the Great Northern Railway, 400 of them are to be used on Rodgers ballast cars and 800 on 50-ton steel ore cars.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY.—During the month of October this company, whose plant covers 47 acres at West Pittsburg, shipped seventeen million pounds of electrical apparatus, consisting of over 5,000 individual consignments, and in addition to this sent out a large number of local freight and express orders.

THE CRANE COMPANY.—Mr. Charles A. Olson, who for several years has been superintendent of the flanged fitting department, has been promoted to the newly created position of general superintendent of the company. Mr. Olson was formerly superintendent of the St. Petersburg, Russia, plant of the Societe Anonyme Westinghouse.

T. H. SYMINGTON COMPANY.—Mr. David R. McKee, Jr., has accepted a position in the sales organization of this company. He was formerly connected with the Western Steel Car & Foundry Company and with the engineering department of the Delaware, Lackawana & Western Railroad. His headquarters will be at the Chicago office in the Railway Exchange.

WM. B. SCAIFE & SONS COMPANY.—This company, of Pittsburg, Pa., state that they have received a contract from the Pittsburg Railways Company for a steel frame trestle and viaduct 455 ft. long, and varying from 30 to 101 ft. high with girder spans from 26 to 90 ft. This trestle is to be erected over Lowry's Run, near Emsworth, Pa. They have also received the contract for the construction and erection of a structural steel engine house 100 ft. by 50 ft. and 50 ft. high, with a crane run-way, for the Cherry Valley Iron Company at West Middlesex, Pa.

STORAGE BATTERY RECEPTACLE.—The Westinghouse Electric & Manufacturing Company have recently placed on the market a storage battery charging receptacle having many advantageous features, among the more important being a swivel attachment which conforms the receptacle to standard steam railway practice, and allows the car or vehicle to start and pull out the cables without danger of breaking them or the contacts. The apparatus is adapted to both railway and automobile service, and has been adopted by the Pennsylvania Railroad for charging the batteries on their cars.

B. F. STURTEVANT COMPANY.—This company of Boston, Mass., announces that the 30-stall roundhouse of the Intercolonial Railway at Truro, N. S., is being equipped by them with a complete heating and ventilating system, especially designed for the rapid thawing out of engines. An induced draft apparatus is also being furnished for the boiler plant. They also announce that the new machine and smith shops of the Pennsylvania Railroad Company at Hollidaysburg, Pa., are to be heated and ventilated by their apparatus. Also that the car paint shop of the Pressed Steel Car Company, at McKees Rocks, Pa., containing nearly 4,000,000 cu. ft. of space and a similar shop at Allegheny, Pa., for the same company, containing 2,500,000 cu. ft. is to be heated and ventilated with their equipment.

WANTED—"Mechanical Draftsman who understands machine design and repairs and has had practical shop experience. Prefer one who has worked under a shop engineer. State experience and salary expected. Address L. N. G., care of this paper."

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

FEBRUARY, 1906.

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VAUGHAN-HORSEY SUPERHEATER.

CANADIAN PACIFIC RAILWAY.

The Canadian Pacific Railway has, for the past six months, been experimenting with a new type of superheater known as the Vaughan-Horsey superheater. This has been developed, and the patents are being applied for by Mr. H. H. Vaughan, assistant to the vice-president, and Mr. A. W. Horsey, mechanical engineer. Observations and tests which have thus far been made, results of which we expect to be able to present in the near future, show a remarkable economy due to the use of this superheater. The construction is very simple and the cost of repairs should be small. The design is such that any part requiring repair may readily be removed and renewed. The number of joints in the superheater pipes has been reduced to a minimum.

The arrangement of the front end and of the superheater tubes is shown in Figs. 1 and 2. Steam from the dry pipe enters the top or saturated steam header, shown in detail in Fig. 3, and flows through the fingers of the header into 1¼ in. solid drawn weldless steel tubes, inside diameter 15-16 in. These tubes are upset at one end and are forged and bent, by

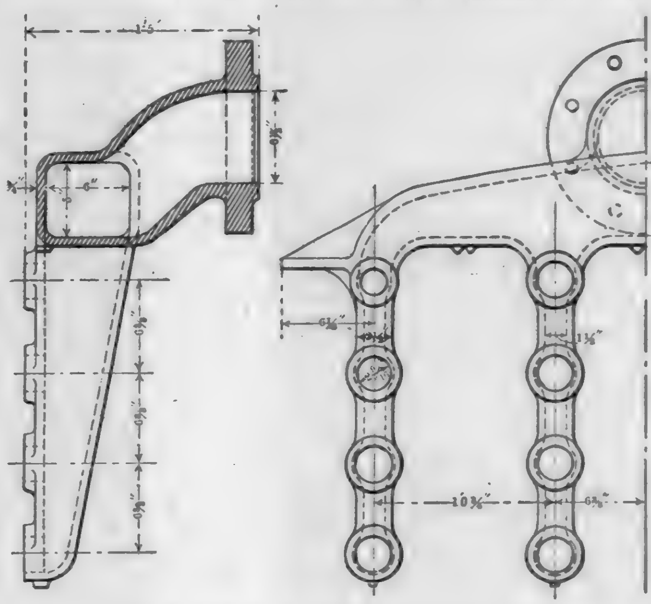


FIG. 3—TOP OR SATURATED STEAM HEADER.

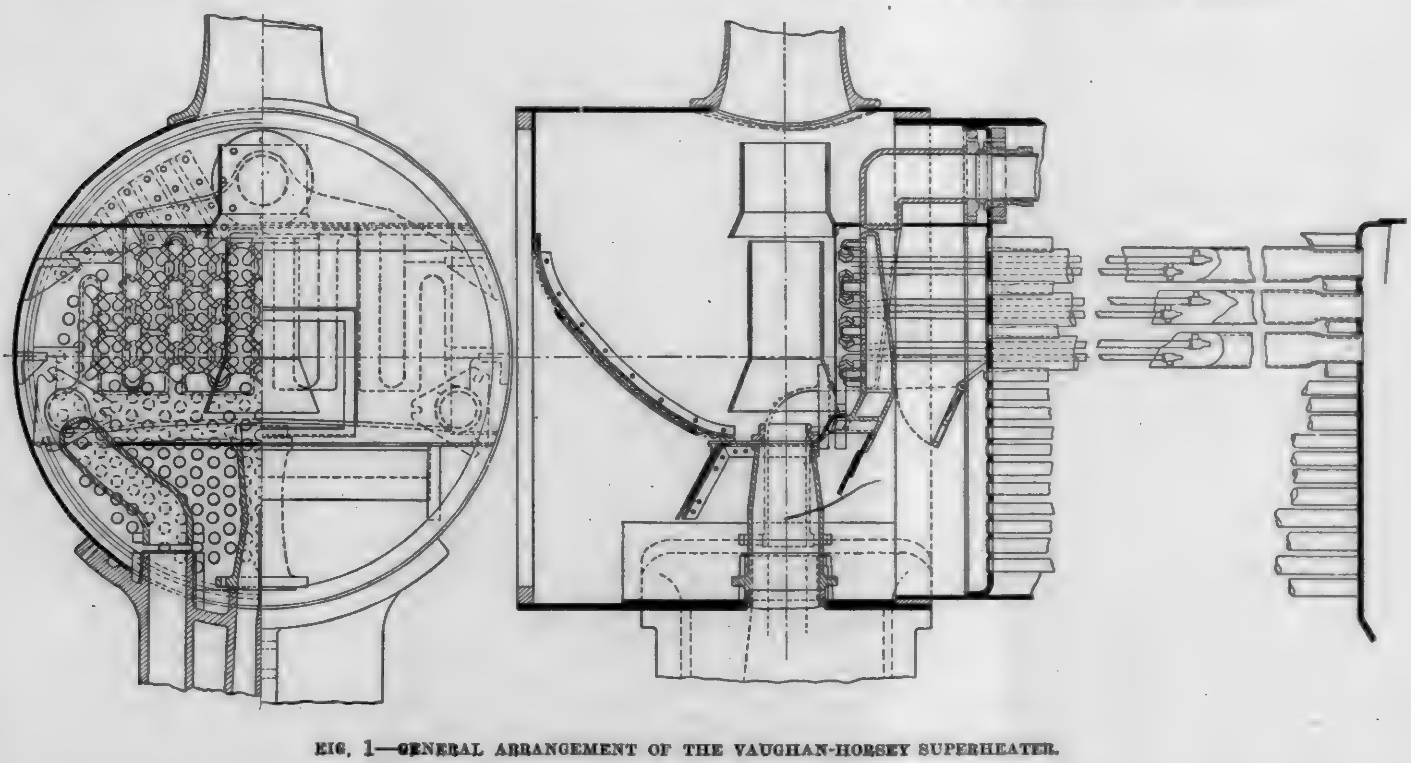


FIG. 1—GENERAL ARRANGEMENT OF THE VAUGHAN-HORSEY SUPERHEATER.

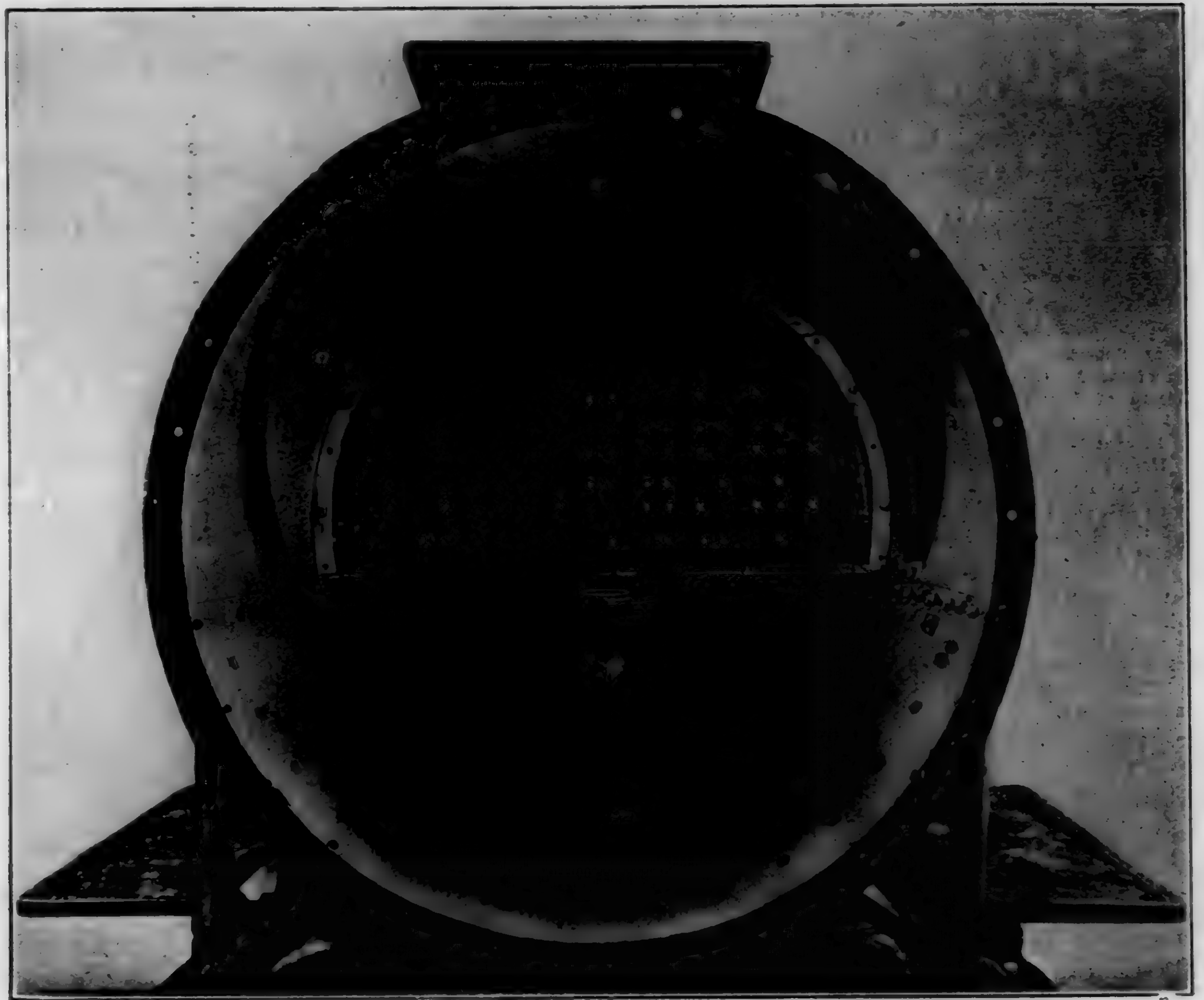


FIG. 2—FRONT END SHOWING ARRANGEMENT OF HEADERS AND SUPERHEATER TUBES.

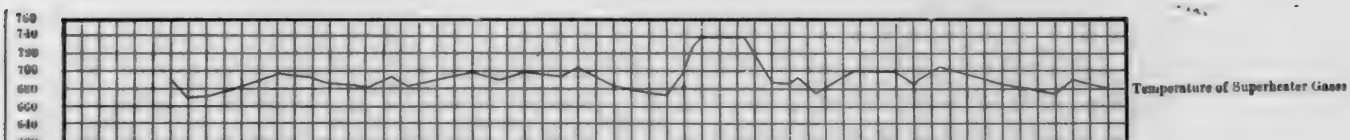


FIG. 3—TEST OF THE VAUGHAN-HORSEY SUPERHEATER—ENGINE 820, JUNE 27, 1905.

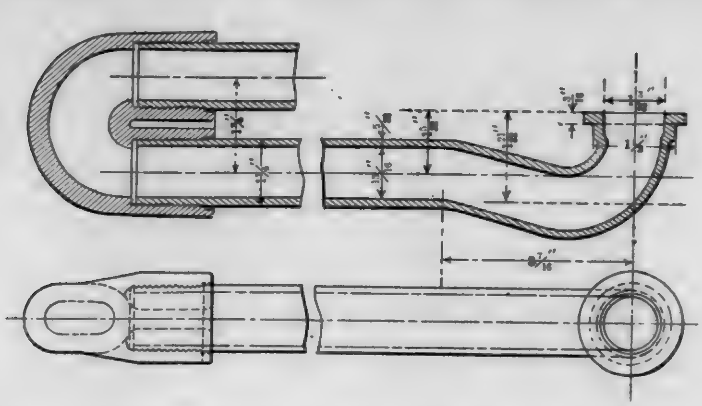


FIG. 4—SUPERHEATER TUBES, SHOWING UPSET END AND CONNECTION TO RETURN BEND.

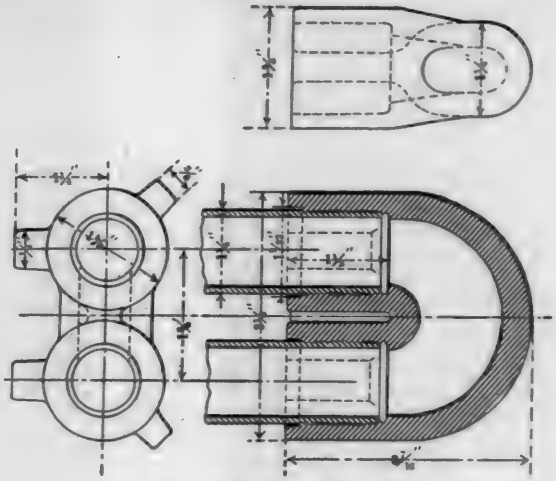


FIG. 5—CAST-STEEL RETURN BEND.

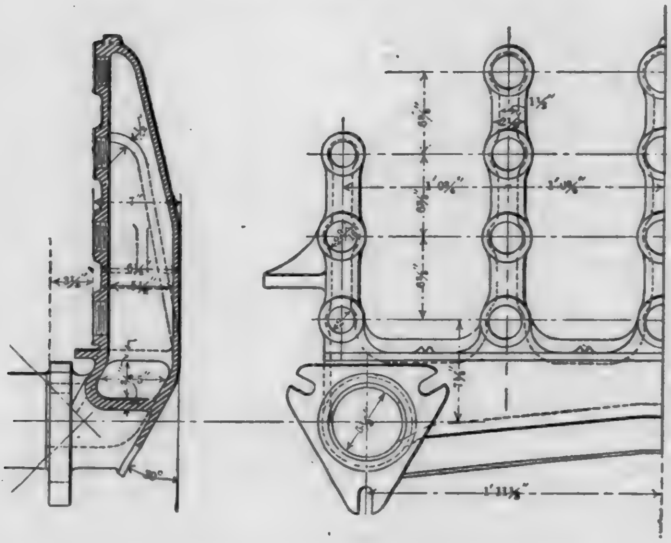


FIG. 6—BOTTOM OR SUPERHEATED STEAM HEADER.

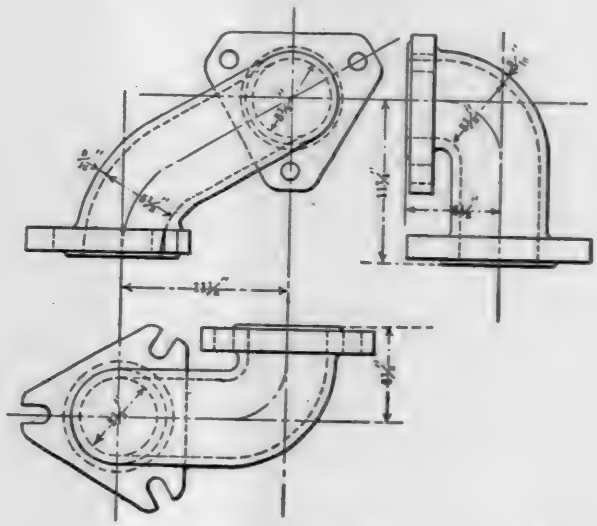


FIG. 7—STEAM PIPE.

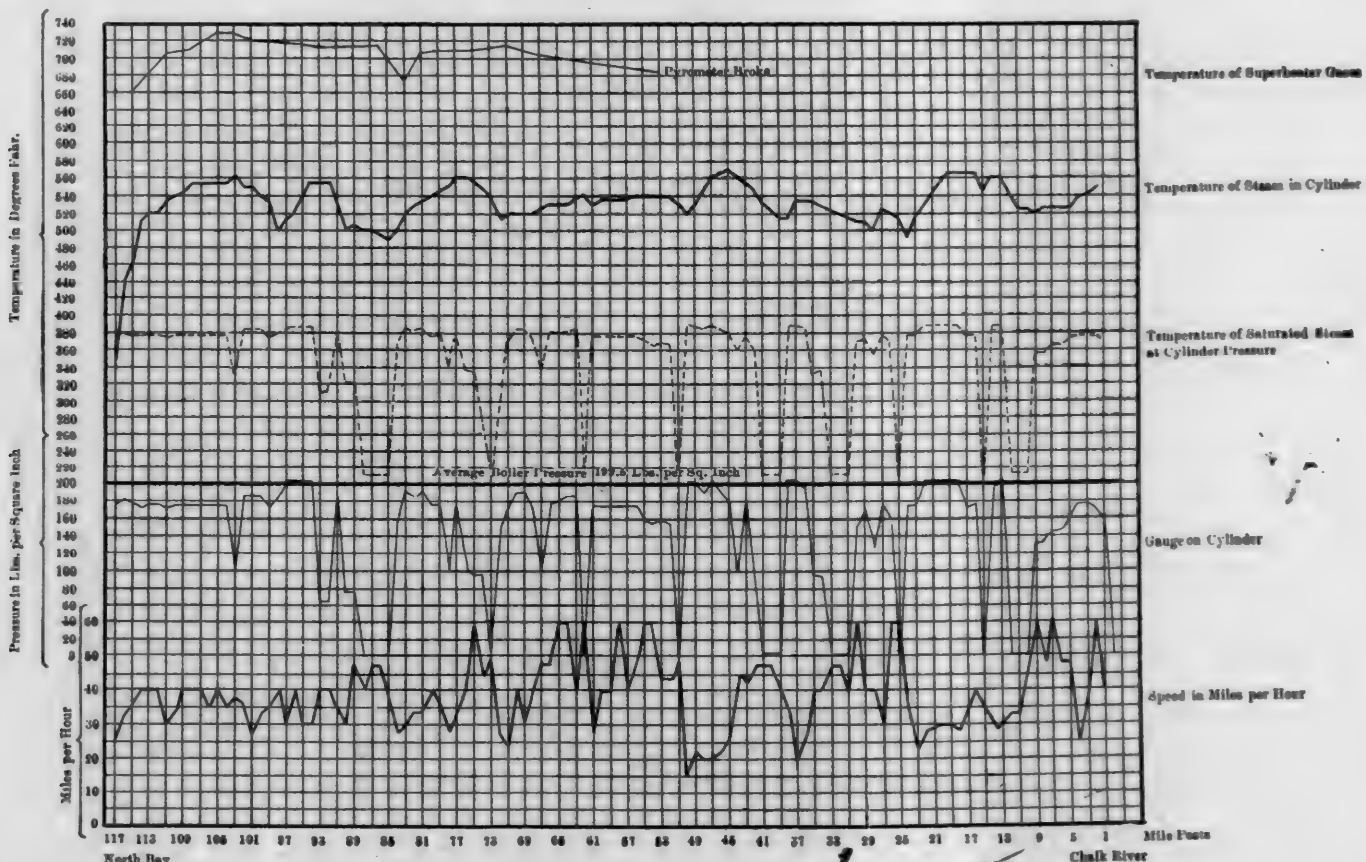


FIG. 9—TEST OF THE VAUGHAN-HORSEY SUPERHEATER—ENGINE 820, JULY 10, 1905.

a bulldozer, to the shape shown in Fig. 4. They are connected by mild steel union nuts to special cast-steel fittings which screw into the header; a 1-16-in. copper wire gasket is used in the union nut. As shown in Fig. 2, these small tubes extend into large 5 in. superheater fire tubes and to within about 30 in. of the back tube sheet, where they connect with the heavy cast-steel return bends shown in Fig. 5. The steam returns from the return bend through 1¼ in. tubes, which connect through union nuts and special cast-steel fittings, similar to those mentioned above, with the fingers of the bottom header, which is shown in detail in Fig. 6. The steam pipes which connect this header with the cylinder casting are shown in Fig. 7, and are necessarily very short; however there has been no difficulty in making the joints tight. Each large superheater fire tube contains two of the small tubes from the top header and the corresponding return tubes to the lower header. The return bend has lugs cast on it, which spaces it properly from the sides of the large tube and the other set of small tubes so that there is a uniform circulation space about the small tubes. The cast-steel return bend is made especially heavy at that part which comes in contact with the smoke and gases from the firebox.

The main difference between this superheater and other types is that the headers are entirely independent and any pair of the smaller tubes may easily be removed and replaced without disturbing the others. The headers containing the saturated and superheated steam being entirely separate from each other, there is no tendency for the superheated steam to be cooled off by the saturated steam. In case it should be necessary to remove the small superheater tubes, or do some work on the large tubes at the front end, it is only necessary to loosen the union nuts and withdraw the small tubes. In case an accident happens to one of the small tubes on the road, it can readily be removed and a blind union or cap placed on the fitting. This can be done in a few minutes and the capacity and efficiency of the superheater is only slightly effected by the loss of a pair of tubes. The 5-in. superheater fire tube, 4⅝ in. inside diameter, is swaged down to 3½ ins. inside diameter for a distance of about 5 ins. at the back end, is threaded and screwed through the back tube sheet and beaded over. At the front tube sheet it is expanded to 5¼ ins. outside diameter and is beaded over. The damper which controls the flow of hot gases through the superheater tubes is operated by a piston working in a 1¾-in. diameter cylinder which takes steam from the steam chest. When the engine is taking steam, the damper is forced open, but when no steam is being used a counter weight closes the damper and prevents the hot gases from injuring the superheater tubes. The light steel plate which is placed in front of the end of the superheater tubes to shut them off from the rest of the smokebox is made in three or more sections and may easily be removed, giving access to all joints, in case it is desired to inspect the superheater.

The following tests of passenger engine 820 which is equipped with one of these superheaters may be of interest. This engine has 20x26-in. cylinders, 70-in. drivers, carries a working pressure of 200 lbs. and weighs 126,000 lbs. on drivers, with a total weight of 165,000 lbs. The average speed, the temperature of the superheated steam in the cylinders, the temperature in the superheater box and the average boiler pressure, together with the number of passenger cars hauled and the coal consumption for several trips made by engine 820 are shown in the accompanying table.

Graphical records of two tests made with engine 820 are shown in Figs. 8 and 9. Ten passenger cars were hauled in each test. The temperature of the superheated steam in the first test averaged considerably more than 550 deg., and in the second case more than 530 deg. In Fig. 9 the calculated temperature of the saturated steam at the cylinder pressure indicated is shown in comparison with the actual temperature of the superheated steam recorded. It is interesting to compare these with similar tests of the two locomotives equipped with Schmidt and Schenectady superheaters, reported in connection with Mr. Vaughan's paper on "The Use of Superheated Steam on Locomotives," on pages 122 and 123 of the 1905 "Proceedings of the Master Mechanics' Association." The temperature of the superheated steam, although it is taken in the cylinders instead of in the branch or steam pipes, as is the case with the Schenectady and Schmidt superheaters, is considerably higher, although these tests are hardly a fair comparison, as the Schmidt and Schenectady superheaters were on consolidation engines in freight service, while engine 820, of a different type, is used in passenger service.

TEST OF PASSENGER ENGINE 820 EQUIPPED WITH VAUGHAN-HORSEY SUPERHEATER.

Date of Test.	Direction.	Average Speed M. P. H.	CYLINDER.				Average Gas Tem.		Boiler Pressure Average.	Cars Hauled	Tons Coal Burned.	REMARKS.
			Temperature Fahr.			Pressure Gauge Average.	Superheater Box.	From Fire Tubes.				
			Max.	Min.	Ave.							
June 27, 1905.	East.	35.33	590°	500°	554.27°	170.11	690°	Broken.	195	10	2½	
" 27, "	West.	33.85	590°	520°	560.14°	.....	690°	"	202	13	3½	
July 8, 1905.	East.	36.61	570°	495°	530.86°	.....	703°	"	197	7	2¼	Made up 25 min.
" 8, "	West.	30.55	560°	490°	525.°	.....	704°	"	197	8	2½	
" 10, "	East.	35.76	590°	490°	535.05°	139.43	705°	"	200	10		
" 10, "	West.	33.24	590°	495°	546.21°	145.33	....	"	...	9		

ELECTRIFICATION OF ST. CLAIR TUNNEL.

The announcement has been made by the Grand Trunk Railway System that arrangements have been made for the adoption of electric traction in the St. Clair tunnel, the contract for which has been awarded to the Westinghouse Electric & Manufacturing Company, the work to be started at once and brought to completion as quickly as possible. The system that will be adopted is known as the alternating current system with overhead conductors—the conductors in the interior of the tunnel being placed upon the walls, and in the railway yards they will be supported by steel bridges. The trains will be operated by alternating current locomotives, capable of hauling a passenger train on the grade at the rate of 20 to 25 miles an hour, and a freight train of 1,000 tons at the rate of 10 miles an hour. The interior of the tunnel and the yards on both the United States and Canada sides of the St. Clair River will be lighted by electricity from power that will be generated in the extensive power house that it will be necessary to erect.

The length of the tunnel proper is 6,025 feet and of the open portals, or approaches, 5,603 feet additional, or more than two miles in all, one of the longest submarine tunnels in the world. It is a continuous iron tube, 19 ft. 10 in. in diameter, put together in sections as the work of boring proceeded and finally bolted together, the total weight of the iron aggregating 56,000,000 lbs. The work was commenced in September, 1888, and it was opened for freight traffic in October, 1891, a little more than three years being required for its completion. Passenger trains began running through it December 7, 1891. It cost $2,700,000.

Dr. P. E. Shaw in a recent communication to the Royal Society, described an electric micrometer with which he has found it possible to detect a motion of one fifty-millionth of an inch.

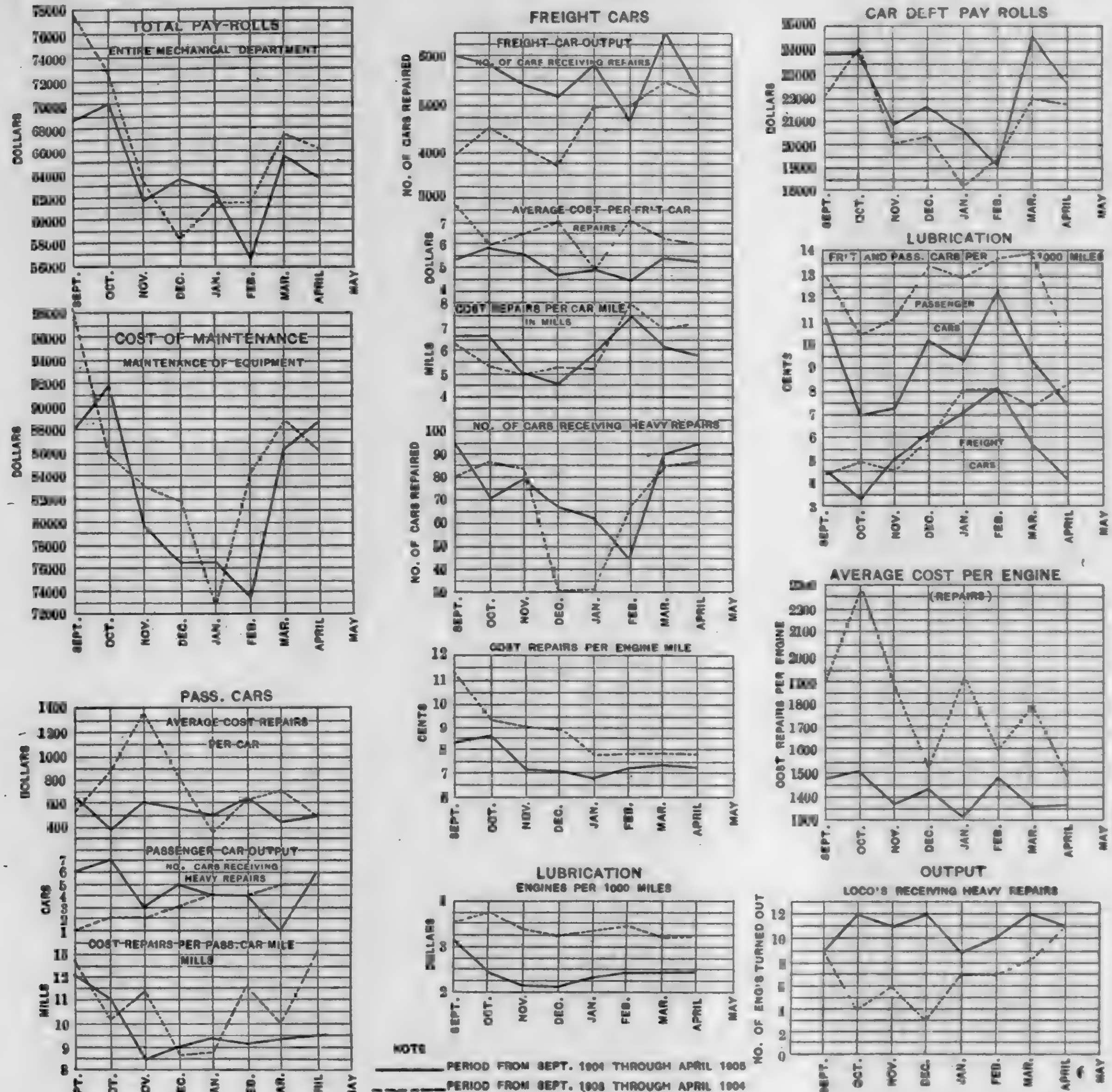


DIAGRAM SHOWING COMPARISON OF EXPENSES AND RESULTS OF THE MECHANICAL DEPARTMENT—KANSAS CITY SOUTHERN RAILWAY.

GRAPHICAL RECORD OF MOTIVE POWER STATISTICS

A series of curves prepared by Mr. W. E. Symons, formerly superintendent of machinery of the Kansas City Southern Railway, illustrate in a graphic manner the improvements introduced in the motive power department of that road, as shown by the standing from September, 1904, through April, 1905, compared with a similar period from September, 1903, through April, 1904. This period includes the winter months and the relative positions of the solid and dotted lines on the diagrams indicate the improvement. The diagrams show in detail the total payrolls, cost of maintenance of locomotives and cars, the output of locomotives and cars, average cost per locomotive for repairs and the cost of lubrication. The diagrammatic method of recording statistics permits the improvement to be noted at a glance, and a few moments devoted to the inspection of these diagrams will serve to show the tendency toward the improvement more clearly than a much longer time devoted to the study of tables of details. These diagrams are presented as an example of the value of graphical statistics to enable the motive power department to not only keep very clear records, but to enable that department to answer questions readily.

These curves show for the motive power department an increase of 2.9 per cent. in the total payrolls in the second period over the first; an increase of 56 per cent. in the output of locomotives; a decrease of 19 per cent. in the average cost of repairs per locomotive; a decrease in the cost of 16 per cent. in the repairs per locomotive mile; a decrease of 29 per cent. in the cost of lubrication per 1,000 miles.

The car department statistics show an increase of 5 per cent. in the payrolls, an increase of 38 per cent. in passenger car output, a decrease of 20.8 per cent. in average cost per passenger car, an increase of 29 per cent. in freight car output, a decrease of 14 per cent. in average cost per freight car, an increase of 11 per cent. in the number of freight cars receiving heavy repairs, and a decrease of 3.2 per cent. in the cost of maintenance of car equipment.

LOCOMOTIVES BUILT IN 1905.—Official returns from all of the locomotive builders in the United States and Canada show that there were 5,491 new locomotives built in 1905, as against 3,441 built in 1904. This total does not include locomotives built by railroads in their own shops, nor does it include orders given for repairs or rebuilding. Of the total number of locomotives reported built, 140 were electric locomotives, as against 95 electric locomotives for last year. Of the total number, 583 were for export and 4,896 for domestic use, including 177 compound locomotives. The total number of locomotives built this year exceeds the total number for any previous year that we have yet reported. The nearest number to it was in 1903, when there were 5,152 locomotives built.—*Railroad Gazette.*

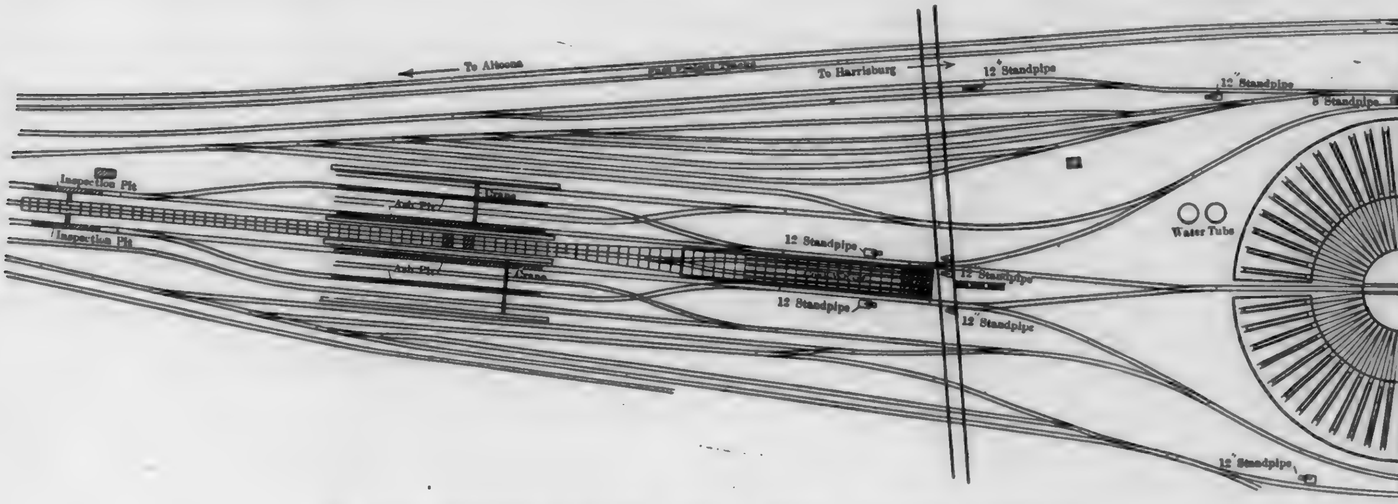


FIG. 1—ARRANGEMENT OF EAST ALTOONA FREIGHT LOCOMOTIVE TERMINAL.

EAST ALTOONA FREIGHT LOCOMOTIVE TERMINAL.

PENNSYLVANIA RAILROAD.

I.

The freight locomotive terminal of the Pennsylvania Railroad, at Blair Furnace, or East Altoona, Pa., which was put into operation a little more than a year ago, is the largest and most complete locomotive terminal in the world. Engines for three divisions—the Middle, the Pittsburgh and the Cambria and Clearfield—use this terminal. At the present time about 300 engines are being handled daily, and on last Christmas Day 214 locomotives were in the terminal at one time. An average of 30 boilers are washed each day. It will undoubtedly be possible to handle a considerably larger number of engines per day, especially if another set of inspection pits are added and the capacity of the power house is increased, both of which can readily be done.

The roundhouse forms a complete circle, and has 50 available stalls, four of which are equipped with drop tables. A space corresponding to two stalls is devoted to a passageway through the house, as indicated on the general plan. Engines are only placed in the roundhouse when they require what is known as heavy running repairs or when the boilers require washing. Engines which require only very light repairs or none at all are placed on the storage tracks.

Locomotives coming into the terminal are first placed on the inspection pits, and after careful inspection pass on to the ash pits, after which they take coal, sand and water, and are then either run into the roundhouse or on to the storage tracks. The storage tracks have a capacity for about 200 locomotives. As may be seen, these tracks are divided into two sections, one of which is used for the Middle division engines, while the larger one is used for the Pittsburgh and the Cambria and Clearfield division engines. As soon as the locomotives which have been placed in the roundhouse have had the necessary work done upon them they are run out on to the storage tracks, so that the roundhouse is used for repair purposes only and not for storage, as is the usual custom. A 100-ft. turn table is used for handling the engines in and out of the roundhouse, while a 75-ft. turn table at the end of the storage tracks is used for turning the engines which do not go into the house, so that they will head out of the terminal in the proper direction. A study of the general plan indicates that careful provision has been made for a free movement of the engines both in and out. The site of the terminal was formerly a large swamp, and it is built entirely on filled ground of an average depth of about 12 ft.

In addition to the features mentioned above the plant includes a power plant, machine shop, oil house, wash house and an office and storehouse building, the upper part of which is fitted with accommodations for the engine crews which have to lay over at this point.

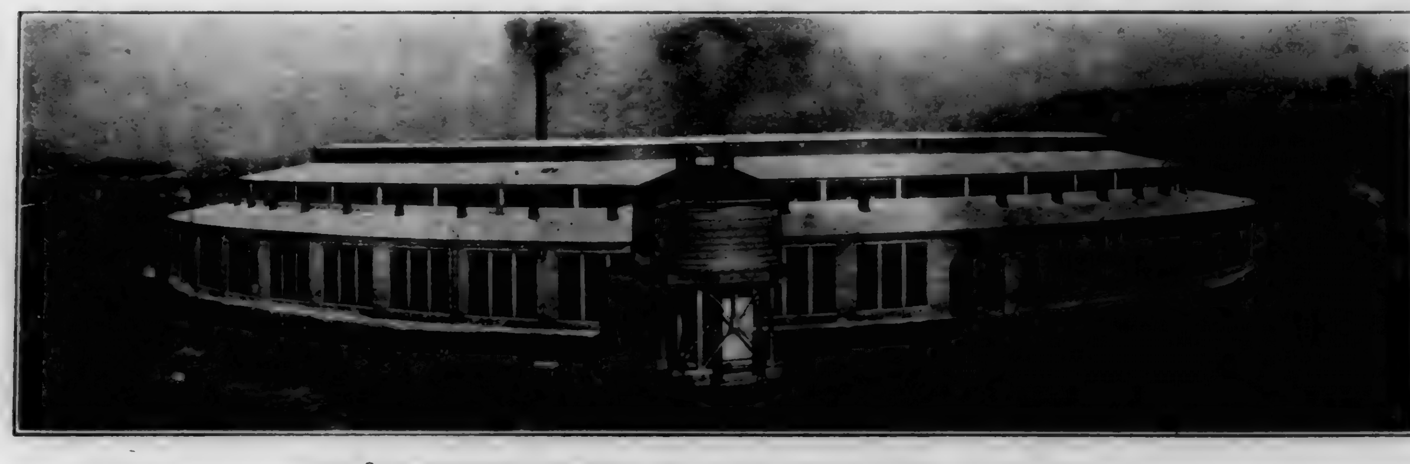


FIG. 2—ROUNDHOUSE, SHOWING TWO OF THE STORAGE TRACKS AT THE LEFT.

INSPECTION PITS.

Two 75-ft. inspection pits are provided, one on either side of the approach to the coal wharf. It is the intention to have these covered over, as indicated in Figs. 3 and 4, although this has not yet been done. There is a passageway between the pits, so that the inspectors can easily pass from one to the other. Ordinarily it takes about three minutes to make a careful inspection of a locomotive. This requires one inspector on either side of the engine and one underneath in the pit. In addition there is one airbrake inspector on the out-

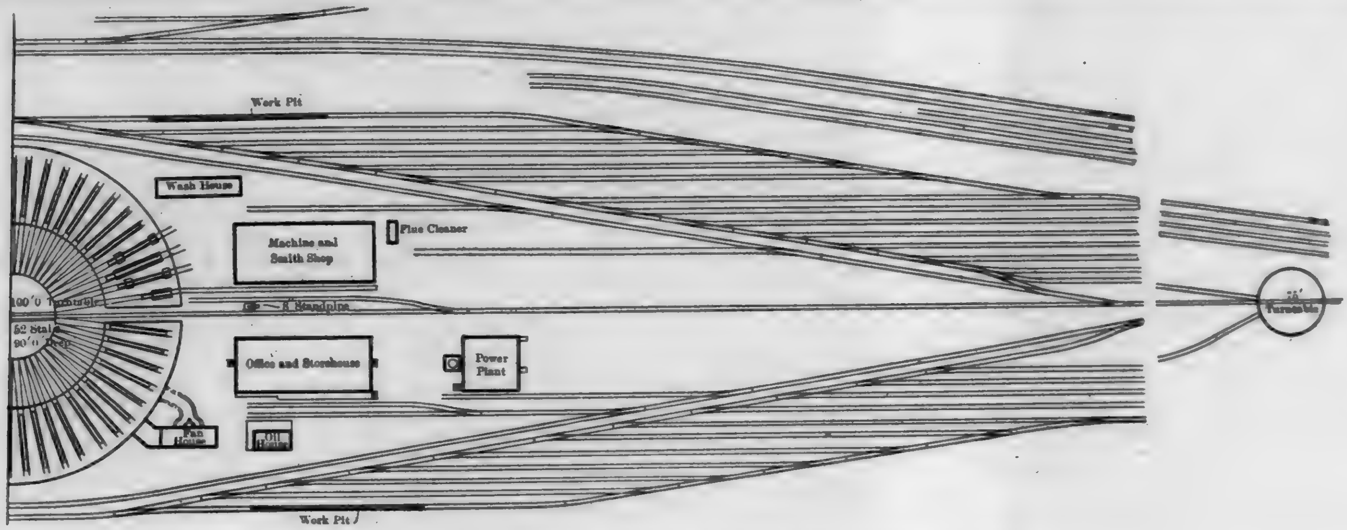


FIG. 1—ARRANGEMENT OF EAST ALTOONA FREIGHT LOCOMOTIVE TERMINAL.

side and one in the cab, who also examines the throttle packing and the cab fittings. The foreman inspector examines the boiler washout and the staybolt tags, and determines as to whether the locomotive is to go into the roundhouse or on to the storage tracks. The walls and floors of the pits are of concrete, and so designed that water falling from the locomotive will quickly drain off. The structure which is to be placed above the pits will have a light steel framework, open at both ends, and the side walls will consist largely of windows. A smokejack will be placed near each end.

ASH PITS.

About 280 ft. beyond the inspection pits are four ash pits, two on either side of the approach to the coal wharf; each is 240 ft. long and will hold four engines. These pits are about trucks which carry ash buckets having a capacity of 48 1-5 cubic feet each. These buckets, shown in detail in Fig. 8, are placed under the engine when it comes over the ash pit, one at each end of the ash pan and one under the front end. After the locomotive has passed off the pit and the ashes have been wet down, the buckets are hoisted and dumped into the cinder cars, which are placed on tracks parallel to the pits. A 5-ton electric traveling crane extends over each set of pits and ash-car tracks. The hoist operates at a speed of 85 ft. per minute; the trolley at the rate of 150 ft. per minute, and the bridge at a rate of 400 ft. per minute. When the ash buckets are ready to dump, they are hoisted high enough so that the two arms on the bucket come into contact with the frame work extending down from the crane bridge and the

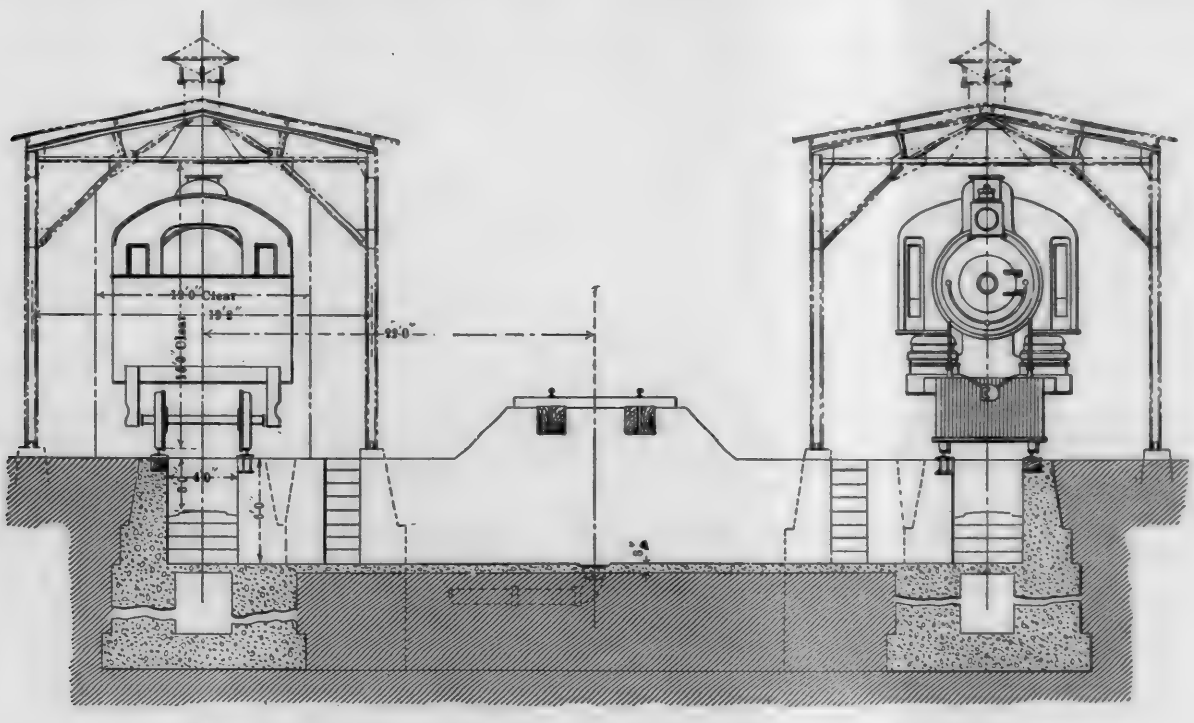
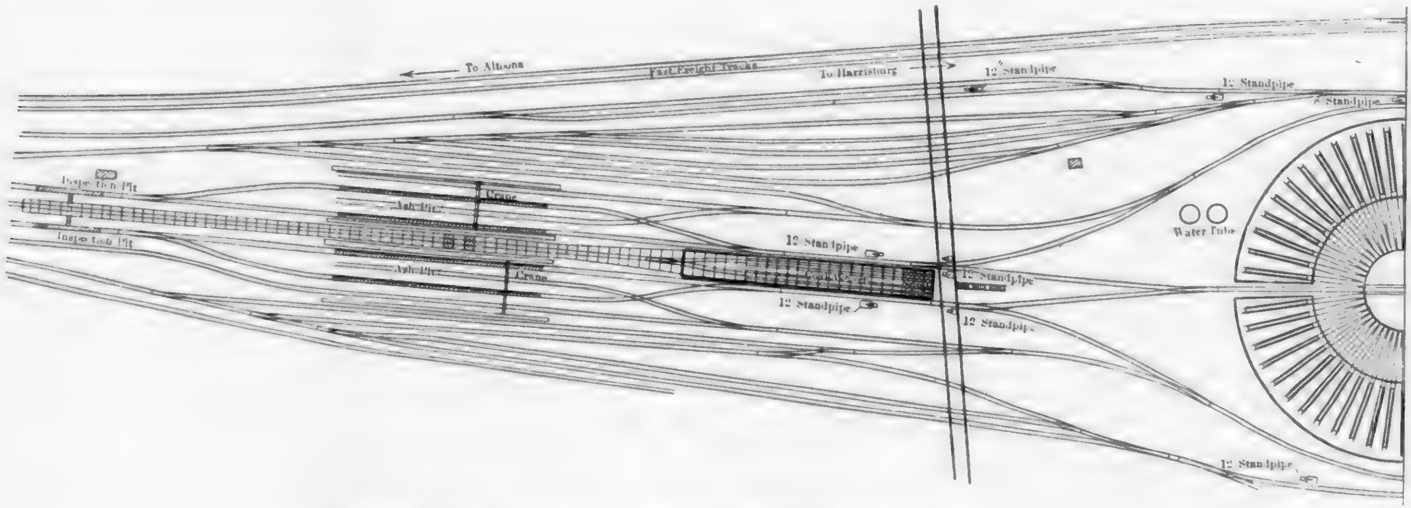


FIG. 3—CROSS SECTION AT INSPECTION PITS, SHOWING CONNECTING PASSAGEWAY.

4 ft. deep, and the walls are of hard, burnt red brick resting upon concrete foundations. The construction is shown in detail in Fig. 7. The pits drain into manholes fitted with removable perforated linings, the bottoms of which are a couple of feet below the center of the sewer pipe. Cinders and dirt settle to the bottom of these linings, or vessels, and, as the dirt accumulates, they may be removed and emptied. The narrow-gauge track on the floor of the pit is for the bucket is forced open. The crane runways are placed on structural steel supports, as shown in Fig. 6.

COAL WHARF.

The coal wharf has fifteen double coal pockets, each with a capacity of 2,136 cubic feet, half of which discharges on each side of the wharf. Provision is made for six additional pockets, if they should be required in the future. The wharf and the trestle leading to it are of timber construction and



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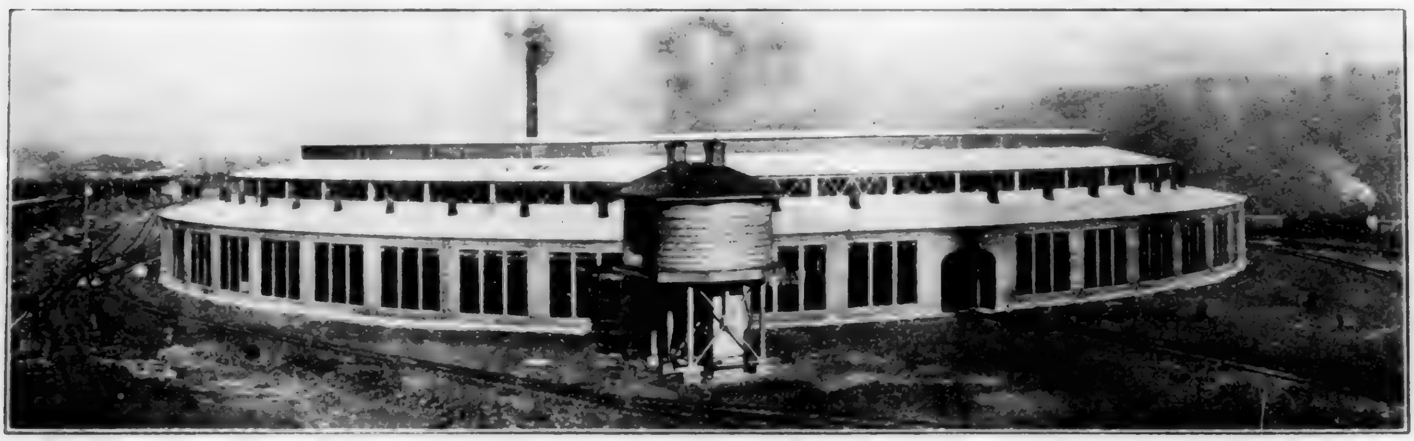

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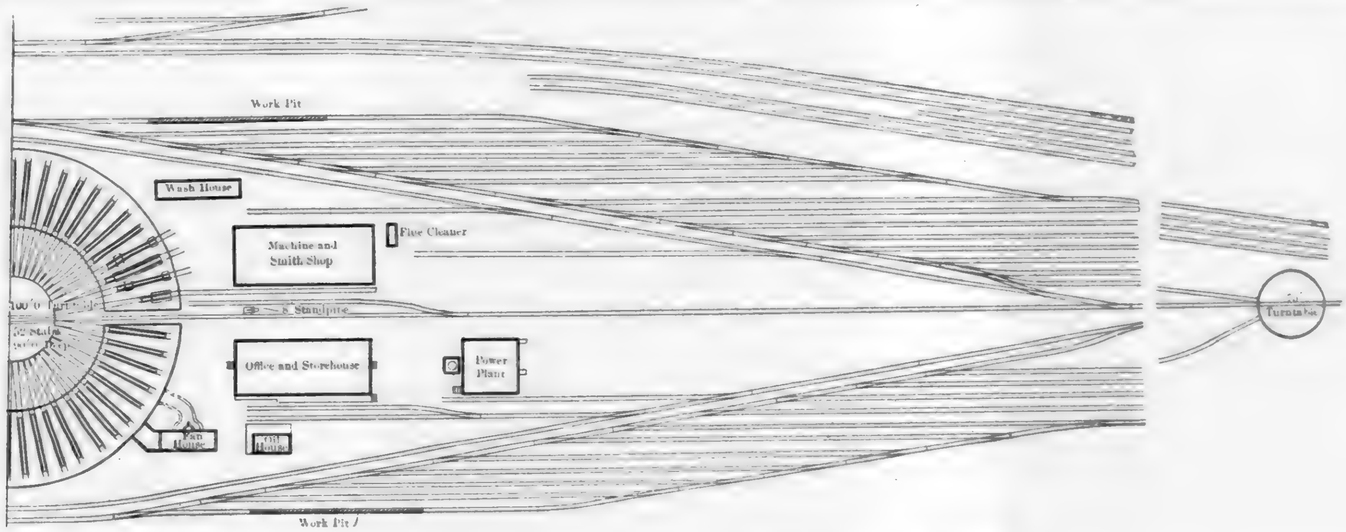

FIG. 1—ARRANGEMENT OF EAST ALTOONA FREIGHT LOCOMOTIVE TERMINAL.

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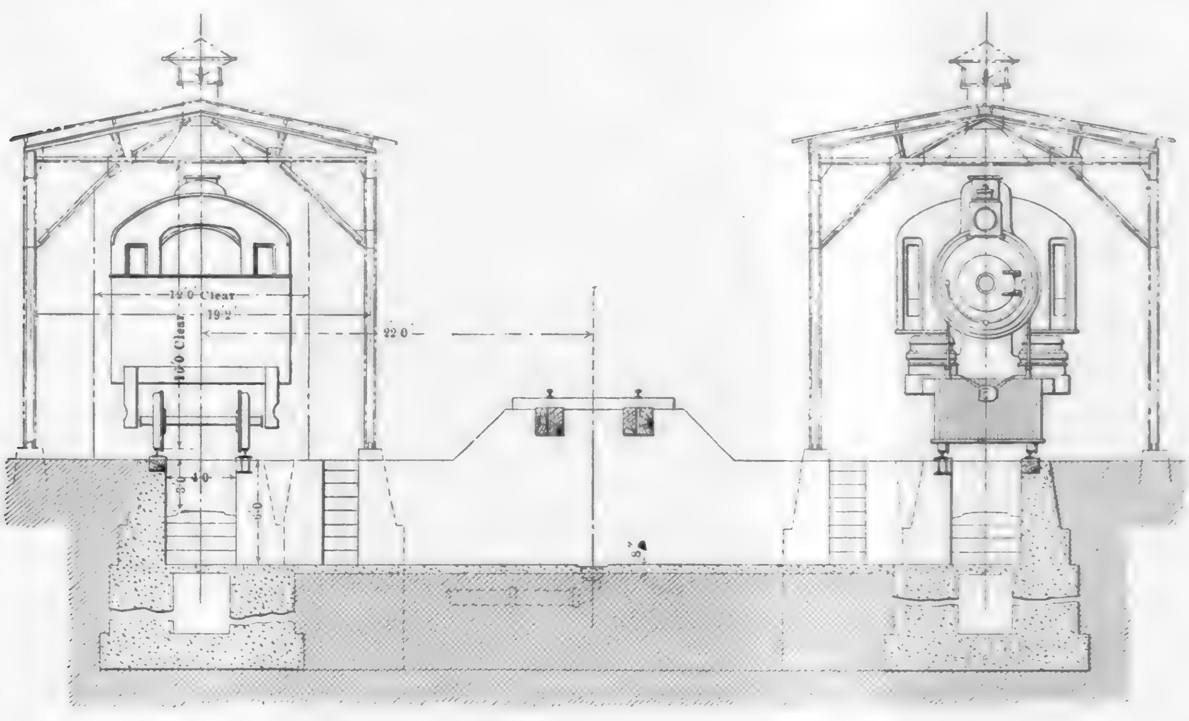

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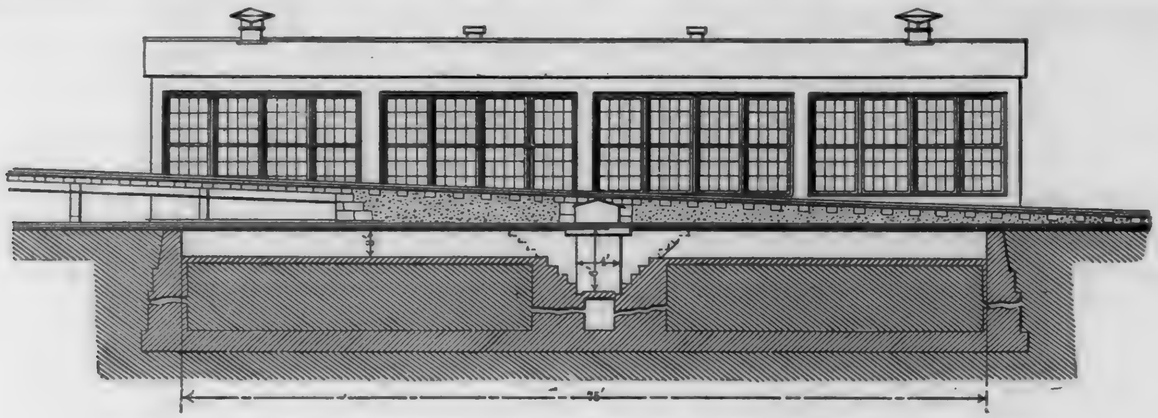
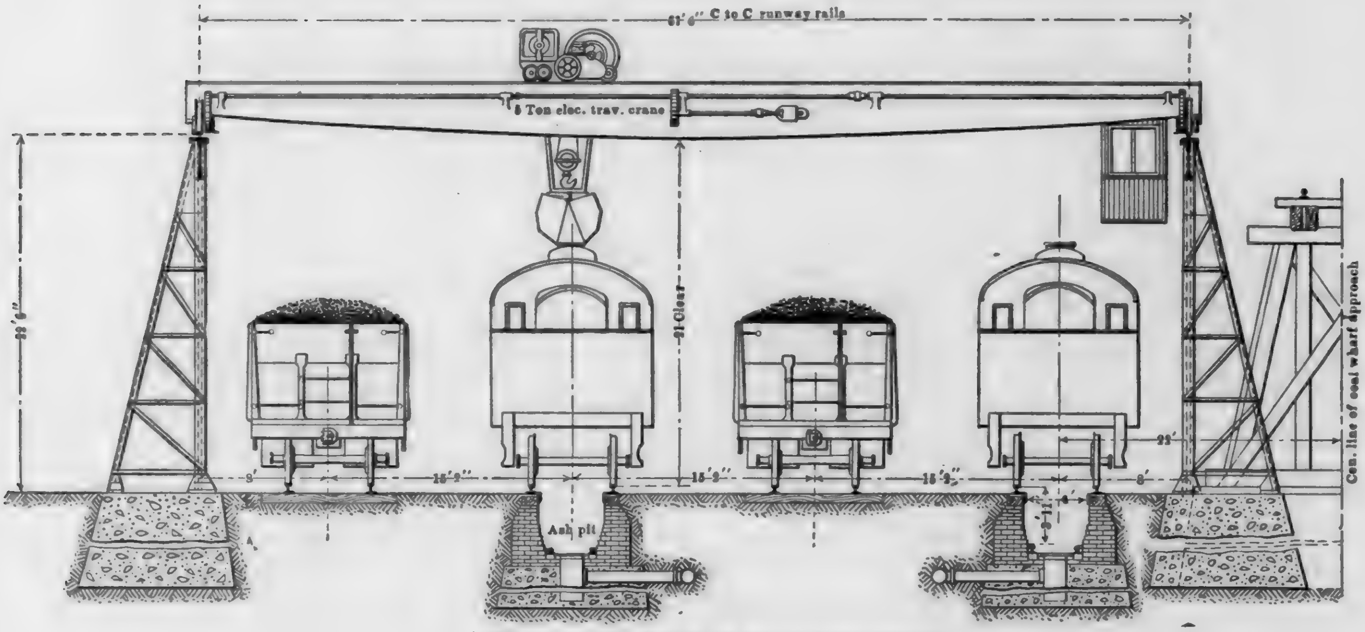


FIG. 4—LONGITUDINAL SECTION THROUGH INSPECTION PIT.



Half Cross-Section through Ash Pits and Crane Runways

FIG. 5—ASH PITS AND TRAVELLING CRANE.

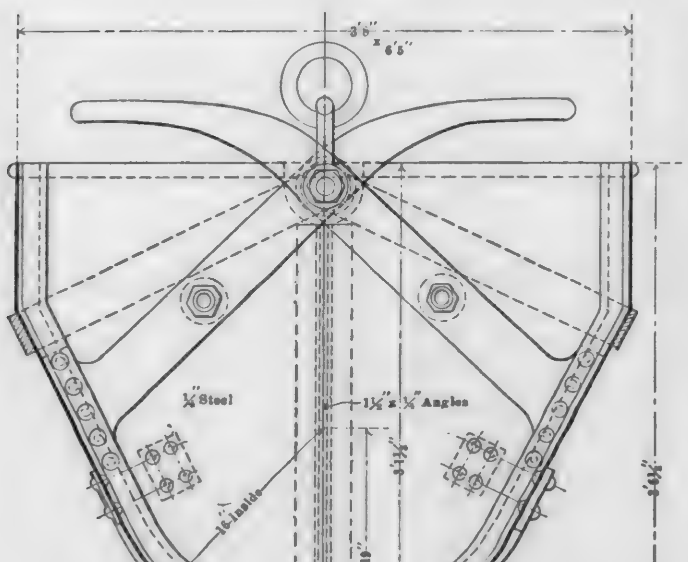


FIG. 8—ASH BUCKET AND TRUCK.

the coal pockets are supported by heavy concrete piers. The approach to the coal wharf is on 3.88 per cent. grade. The top of the wharf is 36 ft. above the ground level. The wharf has a capacity for about 800 tons of coal: at the present time about 1,500 tons are being used daily. Part of the coal pockets are equipped with a special design of Link Belt undercut gate and part with a pneumatically operated gate, designed by the railroad and illustrated in detail in Fig. 12. The air cylinder which operates this door is 6 in. inside diameter. Air may be admitted at either end, depending upon whether the door is to be opened or closed. In the illustration the door is shown closed; when open, it drops so that the flange at the top of the door fits over the top of the coal chute. The deflector at the end of the chute guides the coal toward the middle of the tank.

SANDING APPARATUS.

The general arrangement of the sanding apparatus, which takes up about 36 ft. at the end of the coal wharf, is shown in Fig. 13. Wet sand is delivered directly from the cars on the top of the wharf to the wet sand bins through trap doors. Wet sand is also stored between the concrete piers of the coal wharf and can be delivered to the wet sand bins by a bucket elevator. Directly underneath each of the two wet sand bins is a sand dryer (Fig. 14) which has a drying capacity of 2,000 lbs. per hour. A simple slide-valve regulates the flow of sand from the bin to the hopper. The sand, as it dries, passes through the No. 12 wire netting, 3½ mesh, which is arranged in a cylinder around the stove, and stands almost vertically.

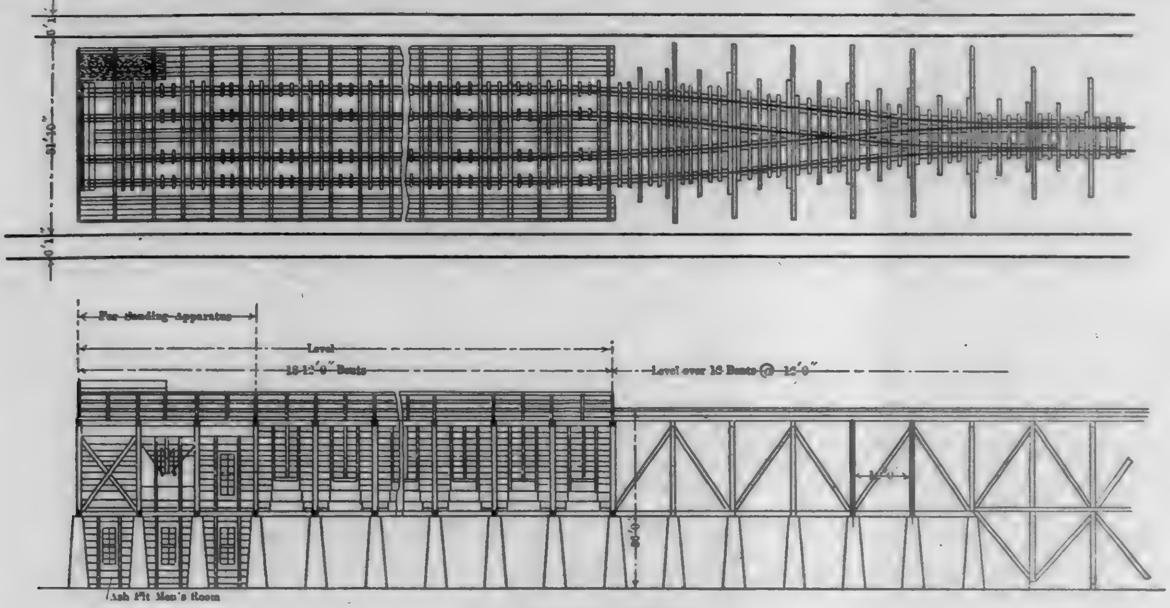


FIG. 9—COAL WHARF.

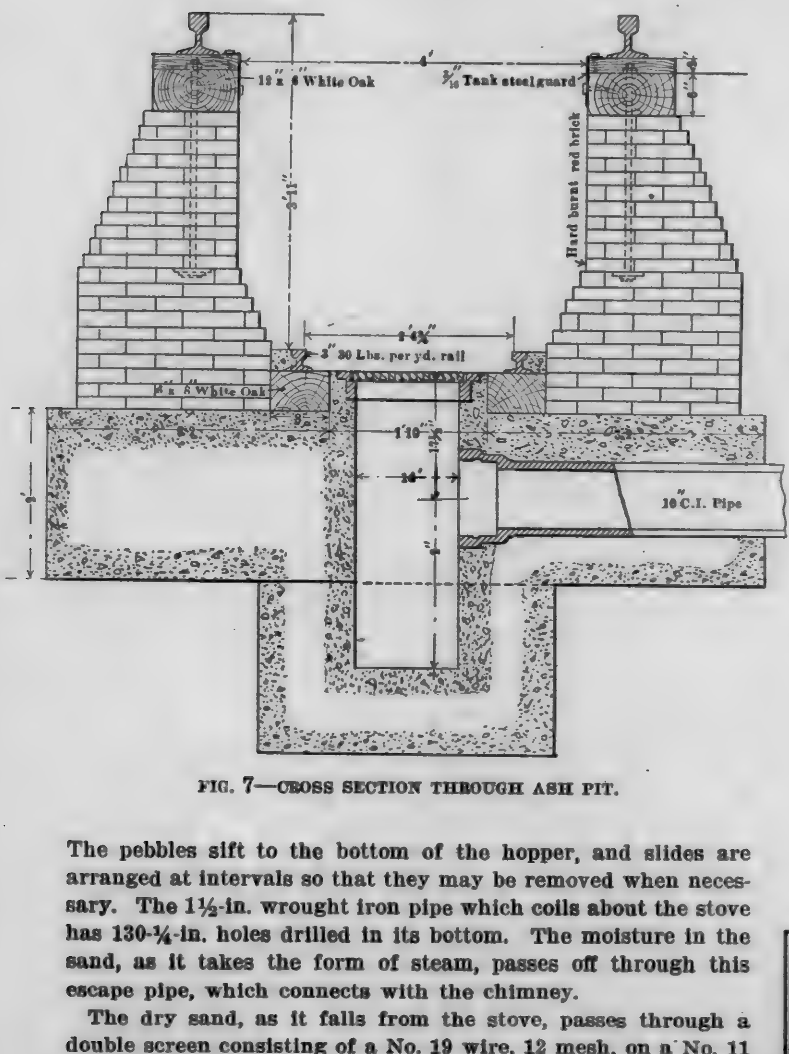


FIG. 7—CROSS SECTION THROUGH ASH PIT.

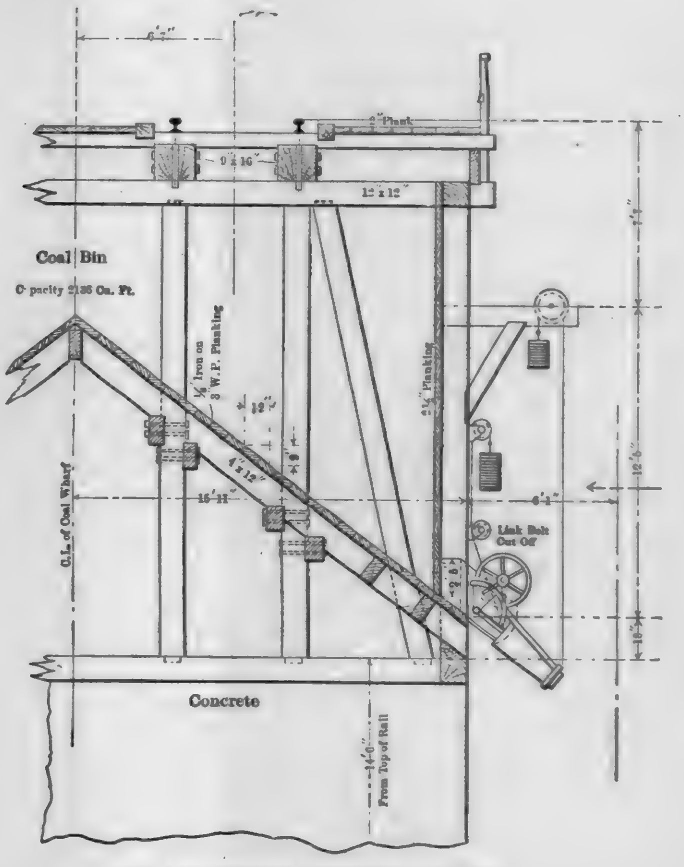


FIG. 11—SECTION THROUGH COAL BIN.

The pebbles sift to the bottom of the hopper, and slides are arranged at intervals so that they may be removed when necessary. The 1½-in. wrought iron pipe which coils about the stove has 130-¼-in. holes drilled in its bottom. The moisture in the sand, as it takes the form of steam, passes off through this escape pipe, which connects with the chimney.

The dry sand, as it falls from the stove, passes through a double screen consisting of a No. 19 wire, 12 mesh, on a No. 11 wire, 2½ mesh. This is arranged on a slope so that the pebbles will be thrown off to one side. The sand falls into a hopper which connects with a tank, or sand reservoir, which has an inside diameter of 2 ft. 6 ins. and is about 3 ft. 8 ins. high inside. When the tank becomes filled, the operator turns an air valve which, at one and the same time, admits air to the small cylinder, closing the plug valve between the hopper and the tank, and also admits air into the reservoir and forces the sand out through the 2-in. pipe at its bottom and up into the dry sand bins. In a more recent installation, the 2-in. pipe is carried vertically through the top of the reservoir,

FIG. 6—ASH PITS AND TRAVELLING CRANE.

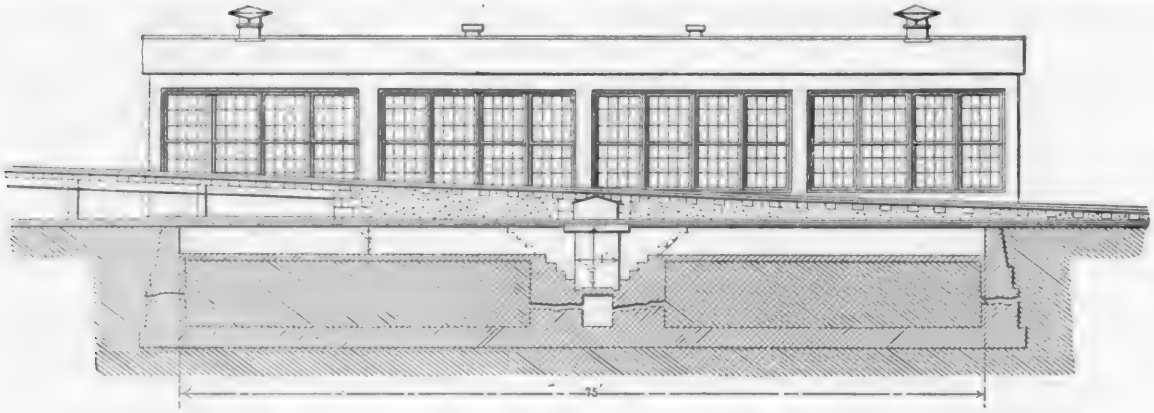
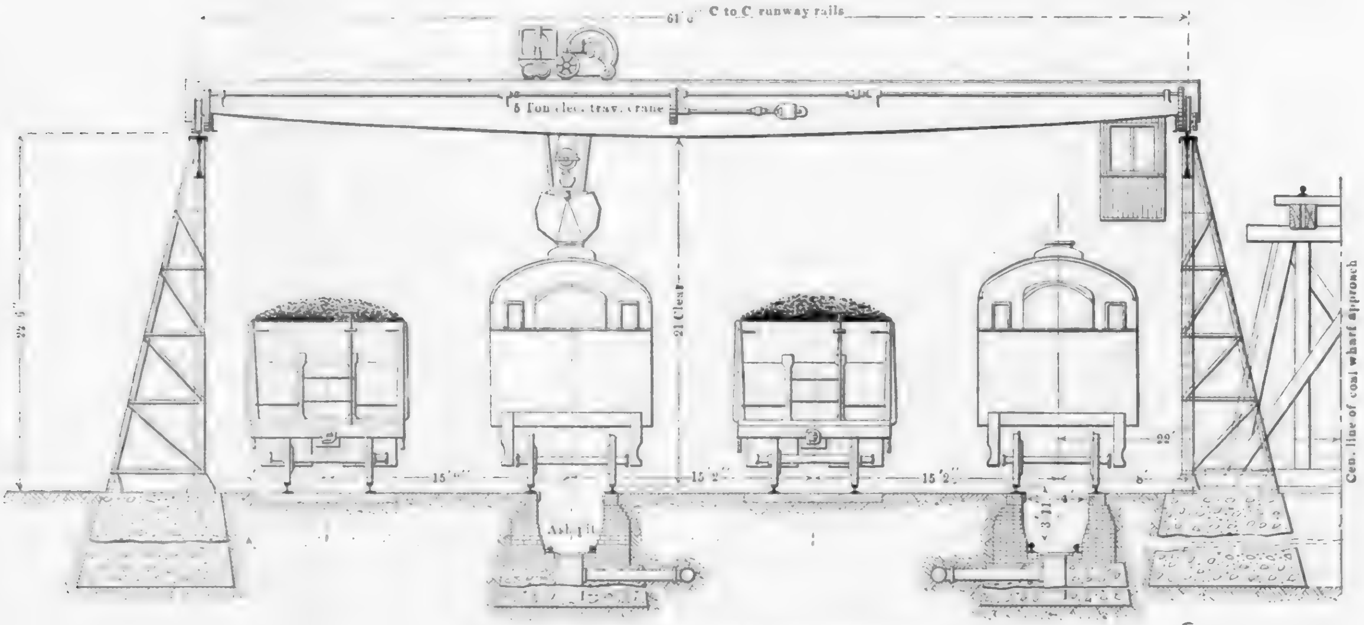


FIG. 4—LONGITUDINAL SECTION THROUGH INSPECTION PIT.



Half Cross Section through Ash Pits and Crane Runways

FIG. 5—ASH PITS AND TRAVELLING CRANE.

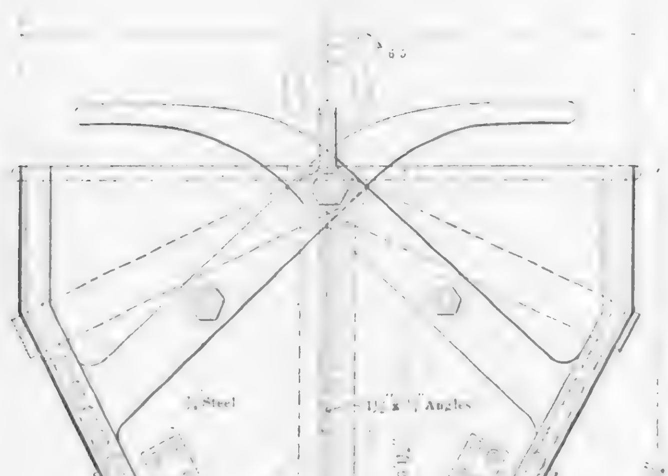


FIG. 8—ASH BUCKET AND TRUCK.

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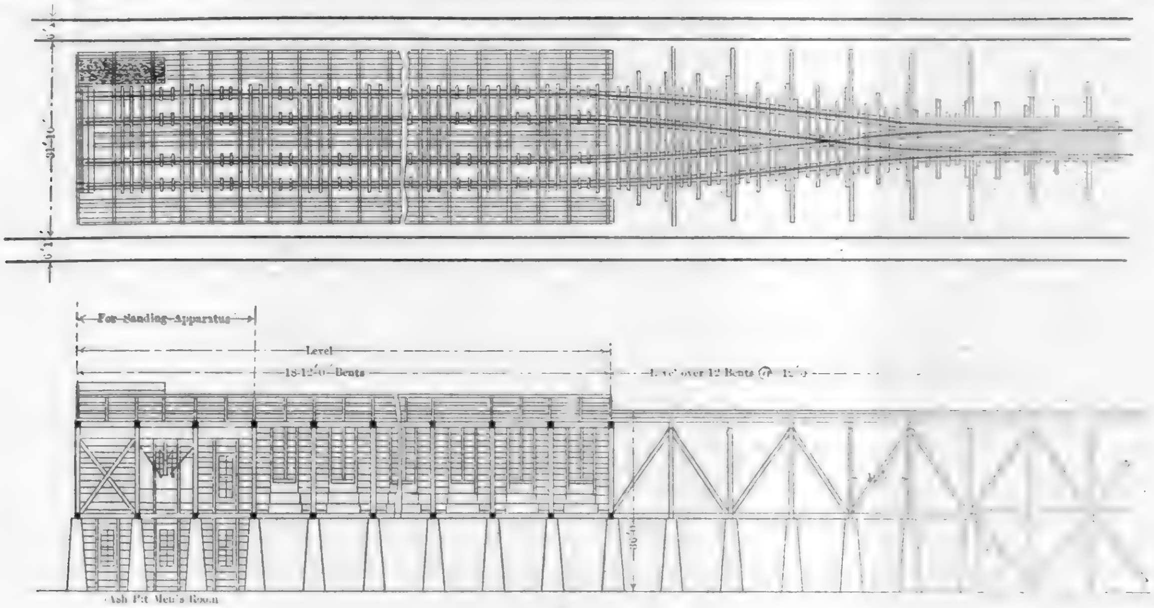

FIG. 9—COAL WHARF.

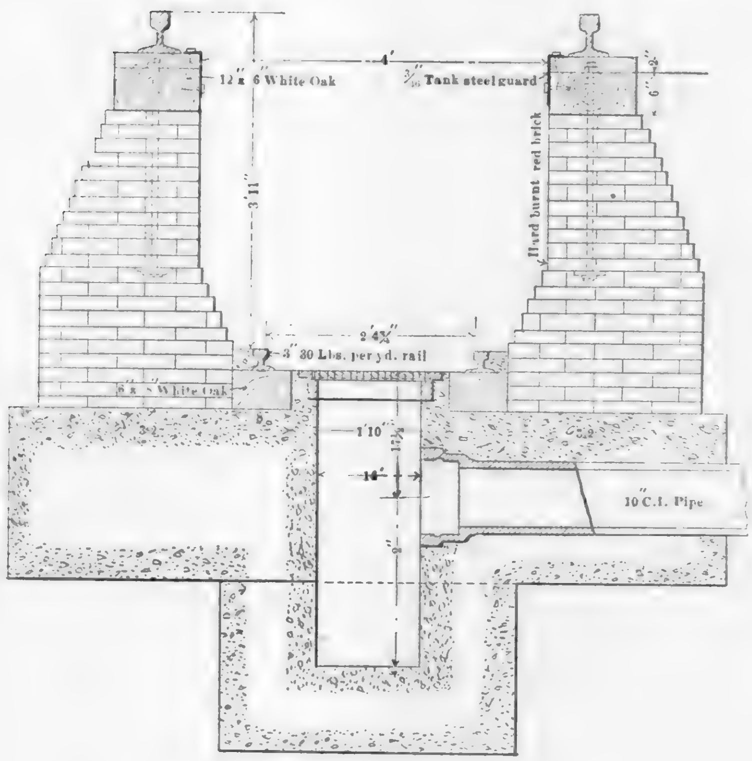

FIG. 7—CROSS SECTION THROUGH ASH PIT.

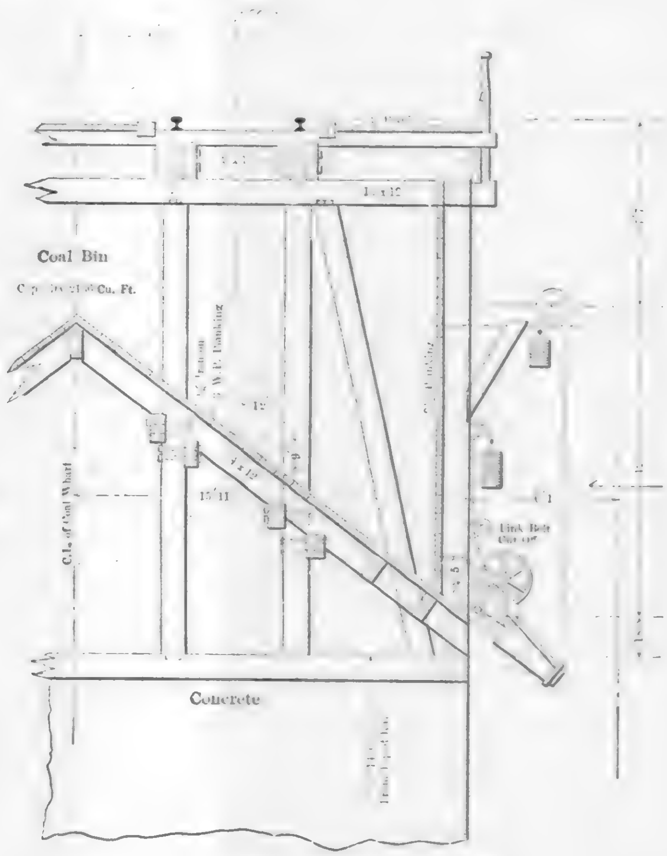

FIG. 11—SECTION THROUGH COAL BIN.

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FIG. 6—ASH PITS AND TRAVELLING CRANE.

FIG. 10—COAL WHARF AND ASH PITS.

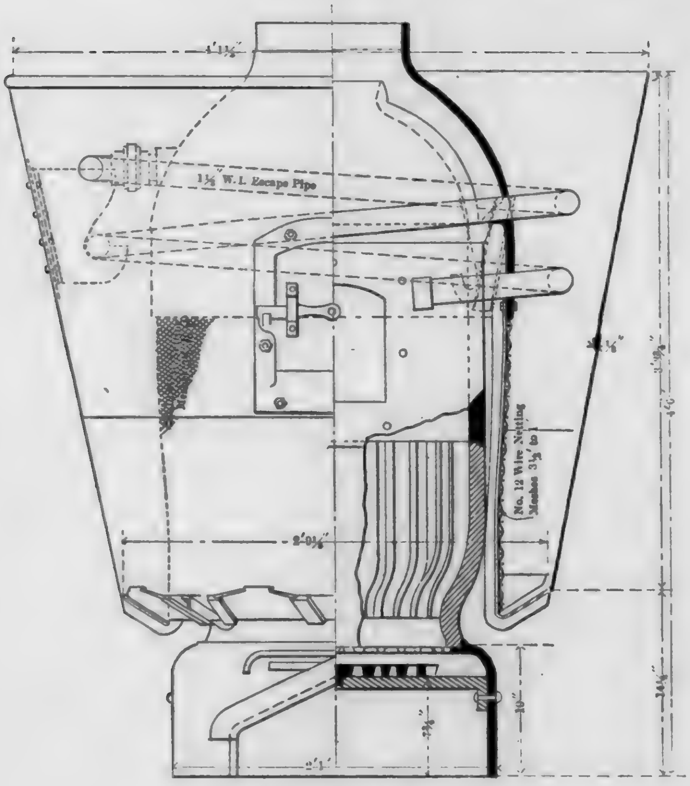


FIG. 14—SAND DRYER.

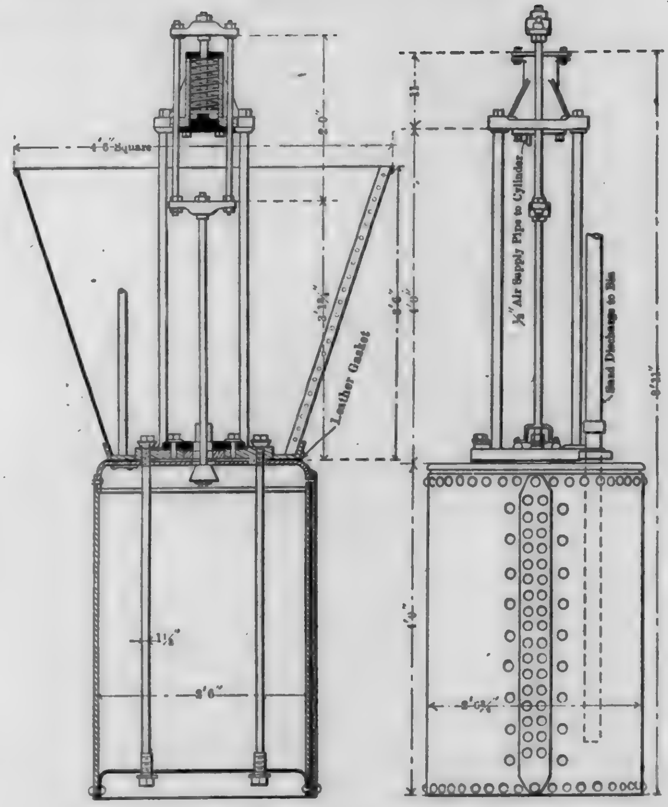


FIG. 15—DRY SAND ELEVATOR.

as shown in Fig. 15, and the sharp bend shown on the general drawing (Fig. 13) is eliminated. The wearing action of the sand at this point makes it necessary to renew the pipe frequently, and this is obviated by using the vertical pipe. The plug valve at the top of the sand reservoir is of steel, case hardened, and seats on a sharp-edged ring. As soon as the reservoir is emptied the air is shut off, and the coil spring in the small cylinder which controls the valve forces the piston downward and opens the valve.

The dry sand bin and the method of conveying sand to the engine are illustrated in Fig. 16. The spout is made of No. 16 galvanized iron and is connected to the casting which leads from the sand bin by a ball joint. The spout is not fastened to this casting, but is held in place by two counterweights; it is thus possible to move the spout up and down or sidewise. The sand valve, which is raised off its seat by pulling the cord, is made heavy enough to quickly drop into place when the cord is released. Any sand which may remain in the ball joint falls into the funnel when the spout is raised and is conducted to the hopper at the sand reservoir; as the spout is elevated, the small lid at its end drops over the opening and prevents rain or moisture from entering.

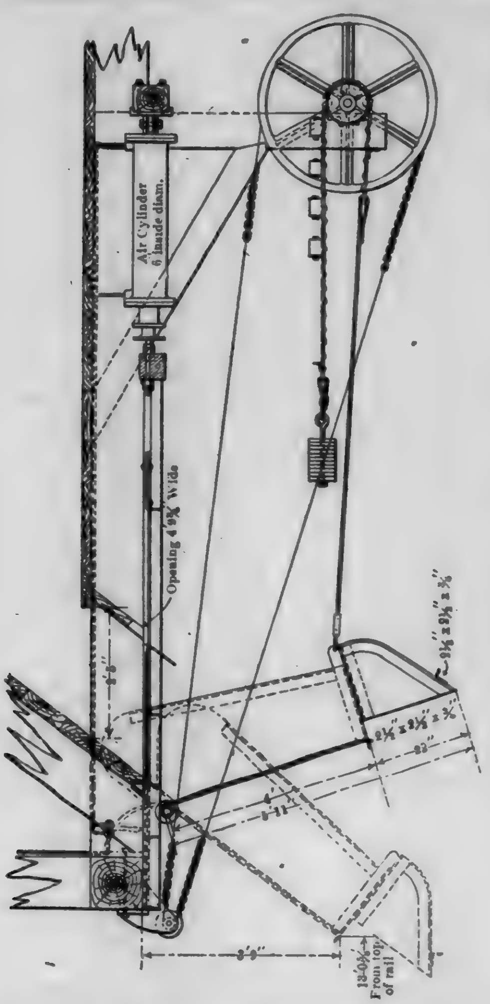


FIG. 12—PNEUMATICALLY OPERATED COAL GATE.

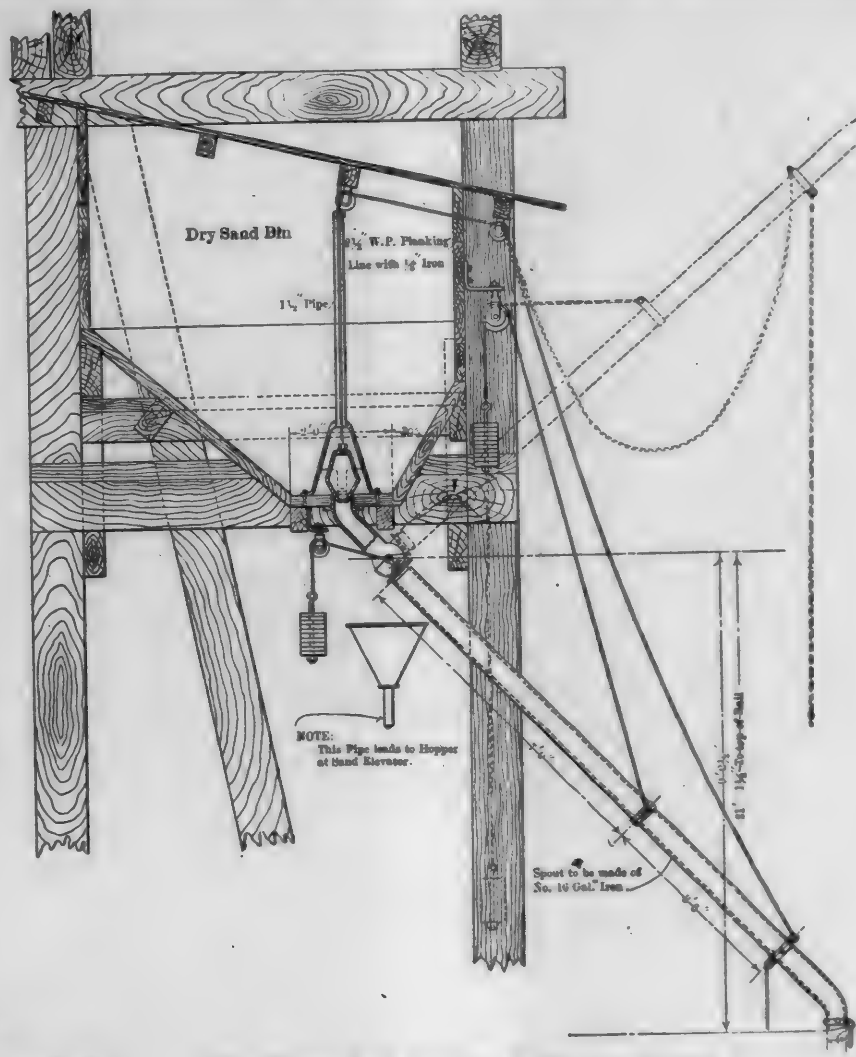
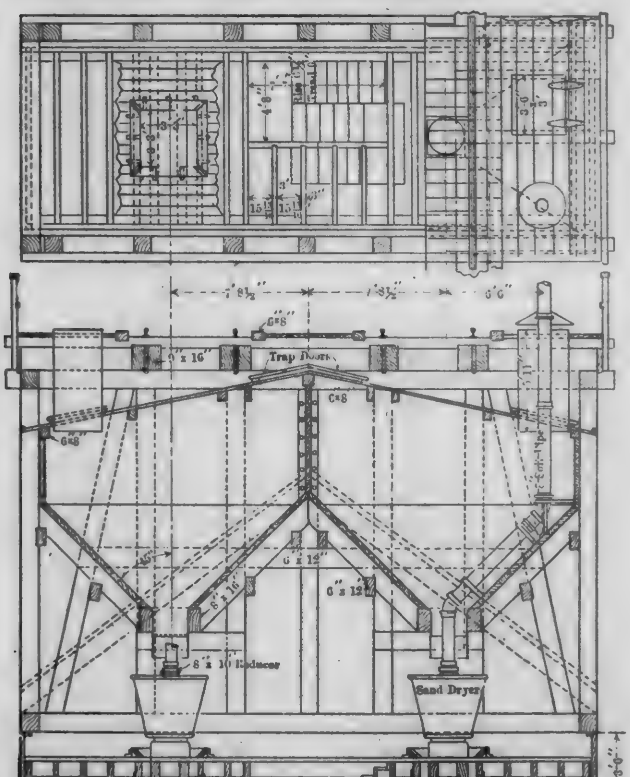


FIG. 16—DRY SAND BIN AND DELIVERY APPARATUS.



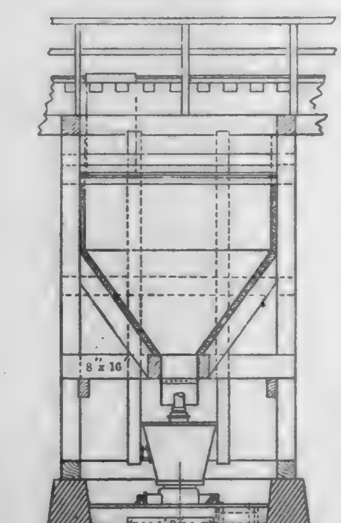


FIG. 13—SECTIONS THROUGH SAND HOUSE.

STORAGE TRACKS.

After an engine has been inspected and had the fire and front end cleaned, and after having taken coal, sand and water, if the boiler does not require washing and no heavy repairs are needed, it passes around the side of the roundhouse to the storage tracks. Each storage track holds only six or seven engines, and this, in connection with the arrangement of tracks leading to and from the storage tracks, makes it possible to take out any engine with a minimum amount of trouble. The tracks are spaced 15 ft., center to center. Steam is kept up and the fires are looked after by an "engine watcher," each watcher being responsible for the engines on two tracks.

The 75-ft. turntable at the end of the storage tracks is driven by a 12½ h.p. General Electric 220-volt motor. The design and construction of the table is similar to that of the 100-ft. table, which will be considered in connection with the description of the roundhouse.

The outside track of each set of storage tracks is equipped with a work pit about 300 ft. long. These

FIG. 10—COAL WHARF AND ASH PITS.

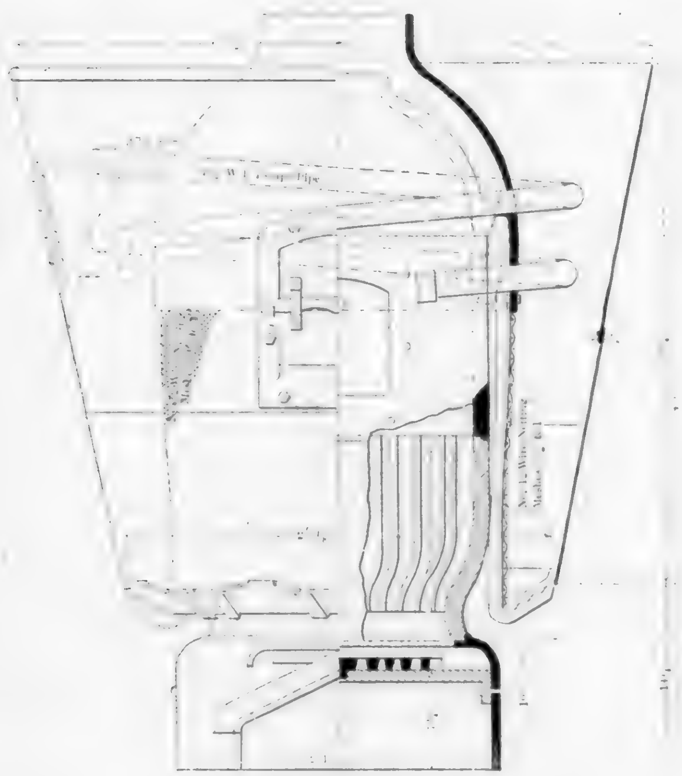
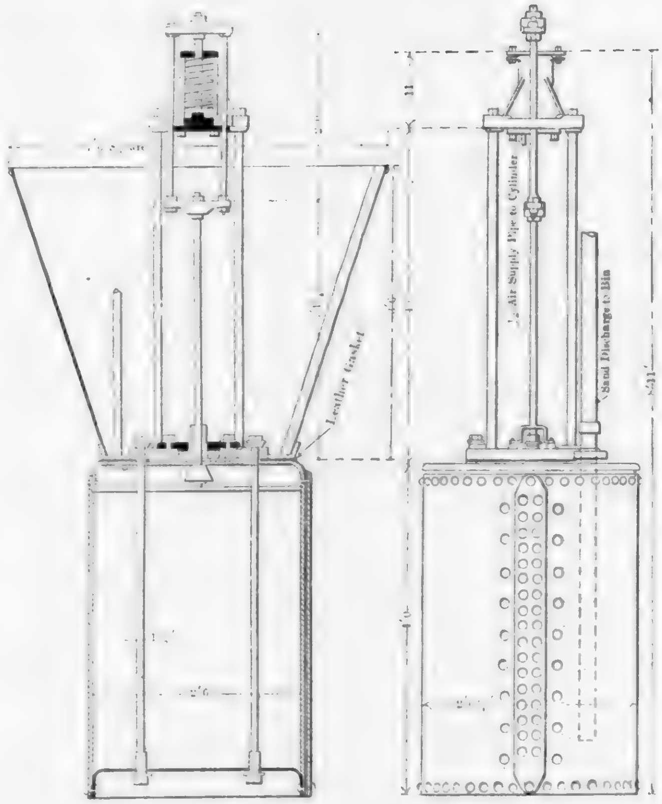


FIG. 14—SAND DRYER.



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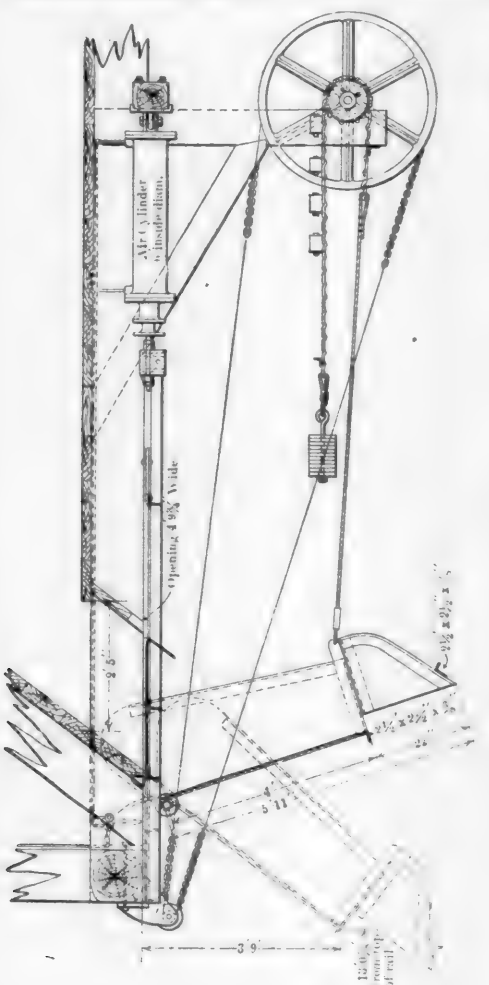
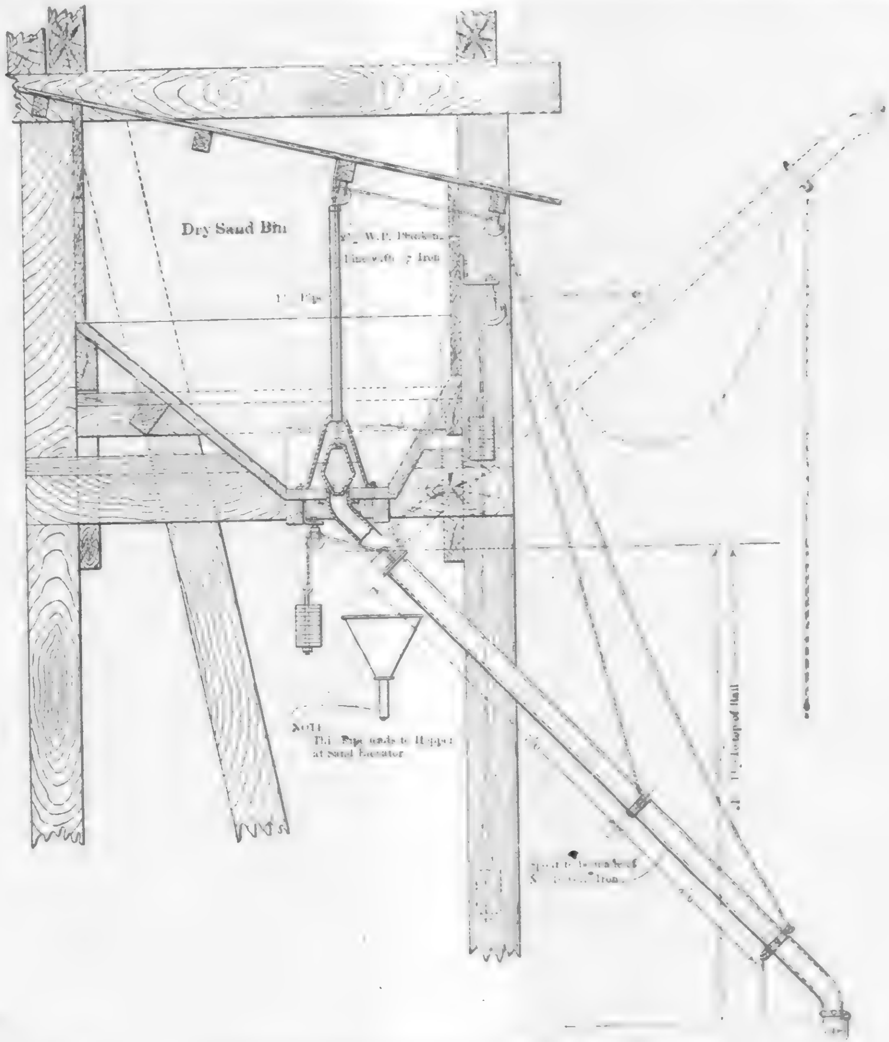


FIG. 12—PNEUMATICALLY OPERATED COAL GATE.



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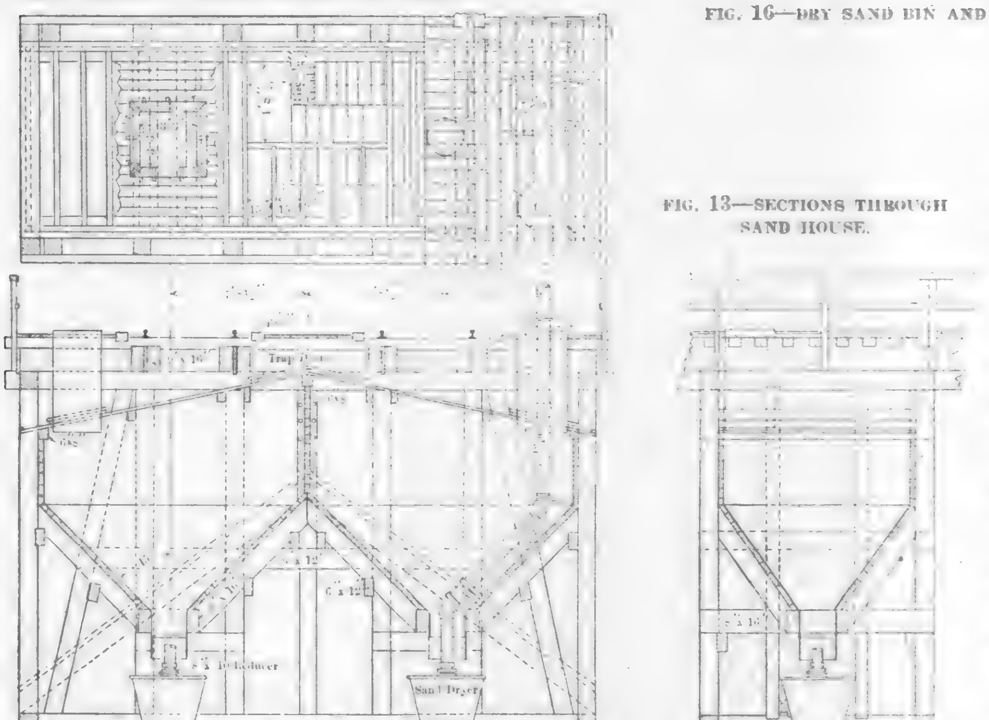

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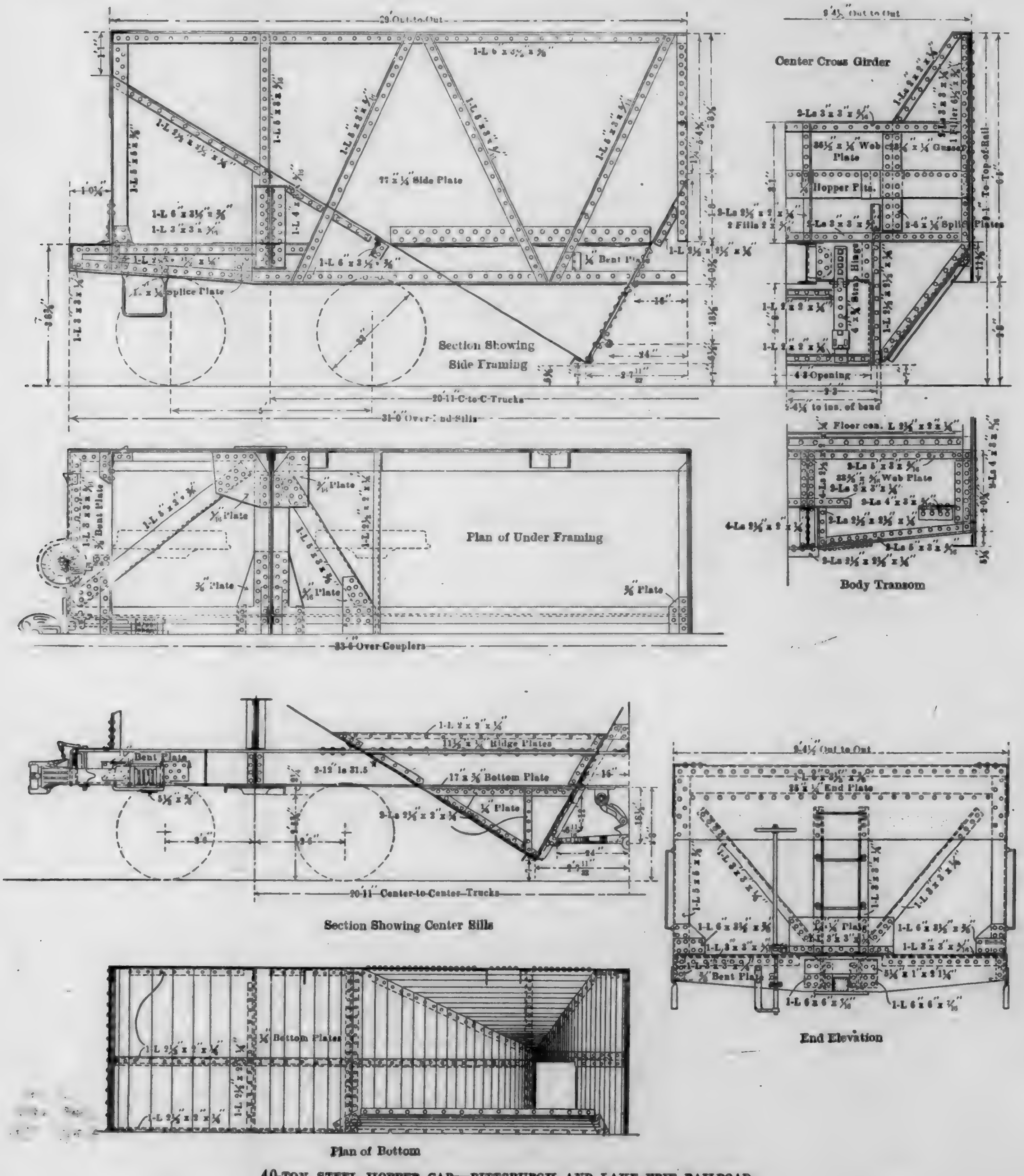
The outside track of each set of storage tracks is equipped with a work pit about 200 ft. long. These

pits are used for making light repairs, such as adjusting wedge bolts, tightening up loose nuts and for sponging driving boxes.

WATER SUPPLY FOR LOCOMOTIVES.

There are two 12-inch standpipes, one on either side of the coal wharf, opposite the coal pockets, and there are three more just beyond the end of the wharf towards the roundhouse, two on one side of the wharf and one on the other. These standpipes are placed in this position so that in whichever direction the engine is heading, or whether it is going in or around the house, a water plug will be convenient to the tender manhole at the same time that the sand box is under the sand spout. On either side of the roundhouse, between the ingoing and outgoing tracks, is an 8 in, emergency standpipe, which is supplied with water from the regular high-pressure service supply line. There is another one of these 8-in. emergency standpipes just beyond the roundhouse, towards the storage tracks. In addition to these, there are three 12-in. standpipes located on the outgoing tracks, two of these on the side used by the Pittsburgh division and one on the side used by the Middle division engines. The 12-in. pipes are supplied from the two large water tubs. The water supply, as well as the other features of the terminal, is arranged to take care of all possible emergencies.

(To be Continued.)



40-TON STEEL HOPPER CAR—PITTSBURGH AND LAKE ERIE RAILROAD.

AN IMPORTANT EARLY DESIGN OF STEEL CAR.

The first steel car built for the Pittsburgh & Lake Erie Railroad was one of the first steel cars to be placed in actual service in this country, and is a very important one, because of the satisfactory manner in which it has stood the very heavy service to which it has been subjected, and also because the various features, although of original design, were not patented; in fact, for this reason the car has proved rather an important factor in the steel car patent litigations during the past few years.

The car is of the hopper type, of 80,000 lbs. nominal capacity, and was designed and built during the latter part of 1897 under the direction of Mr. L. H. Turner, superintendent of motive power of the Pittsburgh & Lake Erie Railroad, by the Youngstown Bridge Company, Youngstown, Ohio. Since that time it has been in constant service, the greater part of the time in a limestone district, where the service is specially severe and the cars are always loaded to their maximum capacity. In spite of this, the car is in practically as good condition to-day as when it was placed in service, eight years ago. In all that time there is no record of any repairs being made, except ordinary repairs to the draft rigging. Not only have no repairs been necessary, but there is no distortion of the top sides, ends or any other part of the body of the car.

40-TON STEEL HOPPER CAR—P. & L. E. R. R.

There are several features of the design, such as the stiffener angle on the top of the sides which projects inward, and the diagonal braces on the inside of the side sheets, which at the present time would be considered objectionable because of their interfering with the unloading on an unloading machine. The car is undoubtedly considerably stronger than cars of the same capacity which are being built at the present time, and there are several features of the design which are worthy of careful study by the steel car designer of the present day.

The general dimensions are as follows:

Height over the sides	9 ft. 1 in.
Width over the sides	9 ft. 4½ ins.
Length over the ends of the hopper	29 ft.
Width, inside clearance at top	8 ft. 4¼ ins.
Length, inside clearance at top	28 ft.
Center to center of bolsters	20 ft. 11 ins.
Truck wheel base	5 ft. 6 ins.
Length over endsills	31 ft.
Cubic capacity	1,335 cu. ft.
Light weight	35,600 lbs.

The center sills are 12-in. I beams, 31.5 lbs. per foot, and extend the full length of the car. The lower inside flange is cut off for a distance of 15½ ins. near each end, to make room for the draft rigging. The end sill is a ⅜-in. bent plate, reinforced by a 3 x 3 x 5-16-in. angle, as shown. The side sheets, two on each side with the joint at the center, are reinforced at both the top and the bottom by 6 by 3½ by ⅜-in. angles, the longer leg of the angle being at right angles with the side sheet and projecting inward. In addition there are diagonal braces on the inside of 5 by 3 by 5-16-in. angles, with the longer leg at right angles to the side sheet. The body is also tied together at the center by a cross girder and gusset, as shown on the general plan. This makes a very strong and rigid construction.

There are two hopper doors, and as the opening is only 4 ft. 3 ins. wide the sides of the hopper are sloped inward toward the center of the car. The center sills are covered by an inverted V-shaped plate, but the sides and bottom of the sills are unprotected. The drop door mechanism is known as the King patent. The body bolster, which is shown in detail on the view showing the general arrangement of the car, consists of a 5-16-in. plate with angles riveted at the edges on both sides; a tie plate riveted to the bottom angles passes underneath the center sills. The ends of the hopper are supported at the corners by upright 5 by 5 by ⅜-in. angles and by 3 by 3 by ¼-in. angles which extend diagonally to near the center of the car. The trucks are of the old Schoen pressed steel type.

LOCOMOTIVE AND CAR BEARINGS.

In a communication presented before the recent meeting of the American Society of Mechanical Engineers, by Mr. G. M. Basford, he stated that the unknown quantities in the matter of stresses to which locomotive parts are subjected place locomotive design in a class by itself. In the matter of locomotive bearings, it is of little practical use to study the coefficient of friction. Rules for bearing pressures, which are entirely satisfactory for other construction, will not answer at all for locomotives. Bearing areas for locomotive journals are determined chiefly by the possibilities of lubrication. They are affected by the very severe service to which locomotives are subject, and the presence of dust, sand, ashes and cinders must be reckoned with. Concerning locomotive bearings, experience has shown that crank-pins may be loaded to from 1,500 to 1,700 lbs. per square inch. These bearings are subject to alternating stresses, rendering lubrication relatively easy, and lubrication is really the limiting factor in locomotive bearings. Wrist-pins may be loaded to about 4,000 lbs. per square inch, because their rotary motion is not complete, and the thrust changes twice in every revolution.

With journals the case is different. For locomotive driving journals it has been found that the following figures give good service: Passenger locomotives, about 190 lbs. per square inch; freight locomotives, 200 lbs. per square inch; switching locomotives, 220 lbs. per square inch.

Car and tender journals present the condition of beams fixed at one end and loaded more or less uniformly. In these cases, two limitations to the size of the bearings are presented: The fiber stresses of the journal must not be too high; there must be sufficient bearing area to insure cool running. As a rule, the various sizes of axles adopted as standard by the Master Car Builders' Association may be loaded slightly more in pounds per square inch of projected bearing area without exceeding the allowable fiber stress, than would be permissible to provide properly against heating; but both of these limitations must be borne in mind. Car and tender bearings are usually loaded from 300 to 325 lbs. per square inch of projected area, but even this unit load is misleading, because in parts the load per square inch of actual bearing area may be very much higher because of the rough character of the bearing.

The Pittsburg & Lake Erie Railroad report for 1905 shows a gross earning of $67,500 per mile, probably the largest amount of any road in the country.

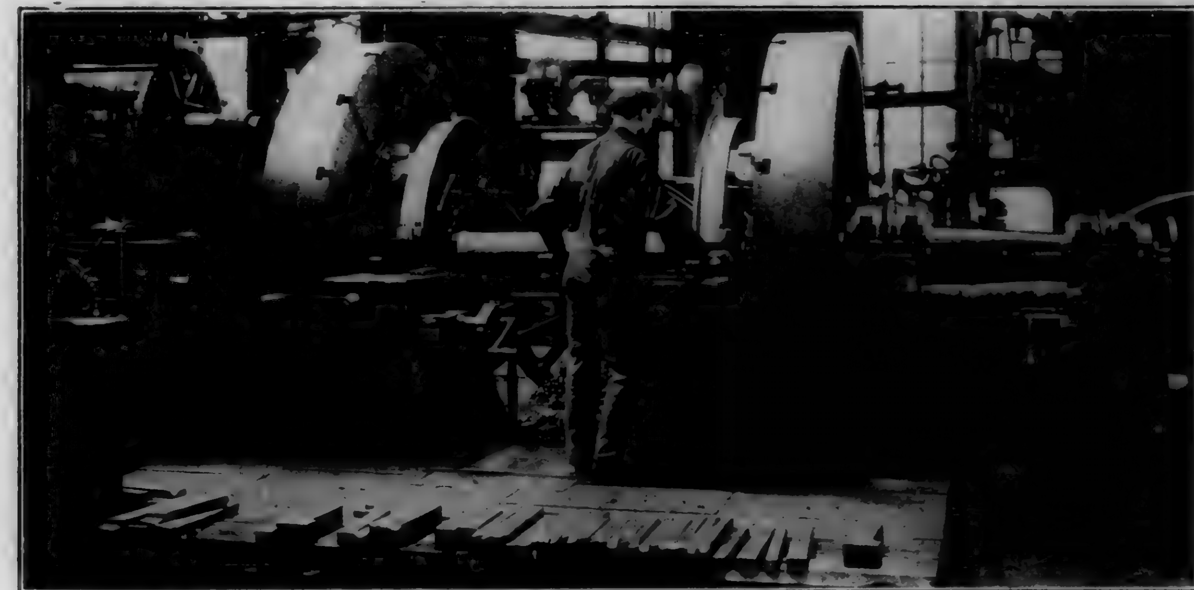
TURNING DRIVING WHEELS.

BY GUSTAVE GIROUX.*

With a powerful up-to-date driving wheel lathe, high speed steel tools and a good organization it is possible to very greatly increase the output over that obtained under ordinary conditions. The reports which have appeared in the technical papers, from time to time, have been received by many with doubt, and it is the purpose of this article to explain in detail just what steps have been taken to increase the output at the Angus shops.

While there are a number of different makes of driving wheel lathes on the market there is more or less difference as to the amount of work which they can turn out in a given time; even the best one might be a disappointment to those who paid a high price for it if attention and consideration were not given to the conditions and organization surrounding it, for these are as important to the output as the machine itself and one is of little use without the other; perhaps it is just these two things which have caused disappointment because of the small output of some expensive and modern wheel lathes which have been installed.

The following statements are based upon the results obtained from a 90-in. driving wheel lathe, direct motor driven, weighing 100,000 lbs., which has been forced and has been in daily service for over twelve months and all it has cost for repairs during that time, both labor and material, would be covered by a ten dollar bill. Such a machine should be set upon a good solid foundation with the top of the base plate or bed practically level with the shop floor. The openings in the bed plate, or pit, should be covered so as to prevent workmen from being hurt by falling or getting caught in them, as well as to prevent the accumulation of dirt and cuttings, and thus keep the surroundings cleaner and more comfortable for the workmen.



FRONT VIEW WITH SHELF FOR TOOLS REMOVED IN ORDER TO PRESENT A BETTER VIEW OF THE MACHINE.

REAR VIEW, SHOWING SHEET IRON CHUTE FOR CUTTINGS.

90-INCH DRIVING WHEEL LATHE—ANGUS SHOPS.

Good sheet iron shoots with flanges should be fastened to the tool posts or rests so as to catch the cuttings as they fall from the tools, and slide them down towards the back of the machine where the helper can conveniently remove them without danger and without interfering with the operator or the running of the machine. On the front side of the machine, or the operator side, a good platform of conven-

*Canadian Pacific Railway, Angus Shops.

ient height and the full length of the machine should be built and upon it a shelf should be placed for keeping tools, etc. The height of this shelf should be about the same as the tool rests, for the convenience of the operator in handling the heavy tools to and from the machine with as little difficulty and exertion as possible. It is also important to have a full set of good wrenches. Two long handle wrenches should be kept, one on each side of the tail stock to loosen or fasten it, one for the helper and one for the operator so that both can do their side at the same time and not have to strain themselves or get on their knees to tighten and loosen the tail stock when removing or putting a pair of wheels in the machine. The same wrench at the back of the machine can also be used by helper in loosening or tightening up driving dog clamps, while the wrench on the operator side can be used for the last or hard tightening down or loosening of nuts or studs of the clamps for the tools in the tool post; a shorter handle wrench should be kept for the convenience of the operator for the first or light tightening down or last or light loosening of the tool post stud nuts.

CHIPS FROM ROUGHING CUT ON A PAIR OF DRIVING WHEEL TIRES.

It is of the utmost importance to have the very best kind of driving dogs, and we have found the patented driving wheel lathe dogs known as the "Sure Grip Drivers," which are comparatively small and simple but very efficient, to give the best results. Four of these dogs are bolted on each face plate with only one bolt in each dog, which bolt fits in one of the slots of the face plate, so that it is easy and quick to adjust them to different diameters of wheels when once the face plates have been graduated for these different diameters. A full description of the "Sure Grip Drivers" appeared on page 439 of this journal for November, 1904. With these driving dogs the wheels or tires are clamped solid to the face plate, and the jarring or vibration which occurs when using dogs driving on the spokes of the wheels is done away with. In twelve months time all the expense we have had with them has been to renew the clamp bolts because of some breaking in the threads and some of the heads pulling off.

The question of the tool equipment is one of very great importance and nothing but the very best, toughest, high speed tool steel should be used and here is where a mistake is often made, which considerably reduces the output of the machine, and that is in persistently using too small a size of steel for the sake of economy, for such an equipment is expensive. The new machine to do better than the old one must have tools capable of standing to the capacity or power of the machine, and on such powerful machines you cannot afford to take chances of breaking high price steel which, by breaking, is also liable to damage the machine and in the long run will prove more expensive than to have used the proper size of steel from the start and kept up the maximum output of the machine.

For the roughing out and flange forming tools it is recommended to use high speed steel 1½ ins. wide by 3 ins. deep of the best and toughest kind, and even tools of this size of certain kinds of high speed steel will break. Tools of this size are easy to keep to shape, the nose on the roughing out tools does not flatten so quickly, and it is an easy size to dress to shape. In dressing the tools it is important that the head be not too high over the body of the steel or the operator will loose time in loosening or tightening down the clamps in the tool post. For those who prefer using built-up tools or tool holders for finishing or scraping tools it is advisable that the body of such tools should be made 3 ins. in height or depth, with countersunk head bolts and a recess for nuts, so the tools can be put in and taken out of the tool posts without necessarily unscrewing stud nuts, or, if of smaller size, without adding a liner to make up for the difference in the height.

Figure 1 shows the tool for roughing out the tread and the flange; Fig. 2, the flange (inside) and throat finishing or scraping tool; Fig. 3, the flange (outside or back) finishing or scraping tool; Fig. 4, the tread (flange and blind tire) finishing or scraping tool; Fig. 5, the taper or bevel tool with radius for either flange or blind tire finishing or scraping tools; Fig. 6, is a tool used to remove hard spots on the tread of the tire which cannot very well be taken out with the roughing tool. With such a tool it is possible to get under the hard spot and cut it out or raise it like a shell. With a set of these tools tires can be turned up very quickly and finished very smooth in a short time.

CHIPS FROM FINISHING CUTS. CENTER ONES AT REAR, 1¼ INCHES X 3-32 INCH; THOSE ON EITHER SIDE 1 INCH X ¼ INCH; CENTRE ONES IN FRONT 3⅝ INCHES WIDE FROM FORMING TOOLS.

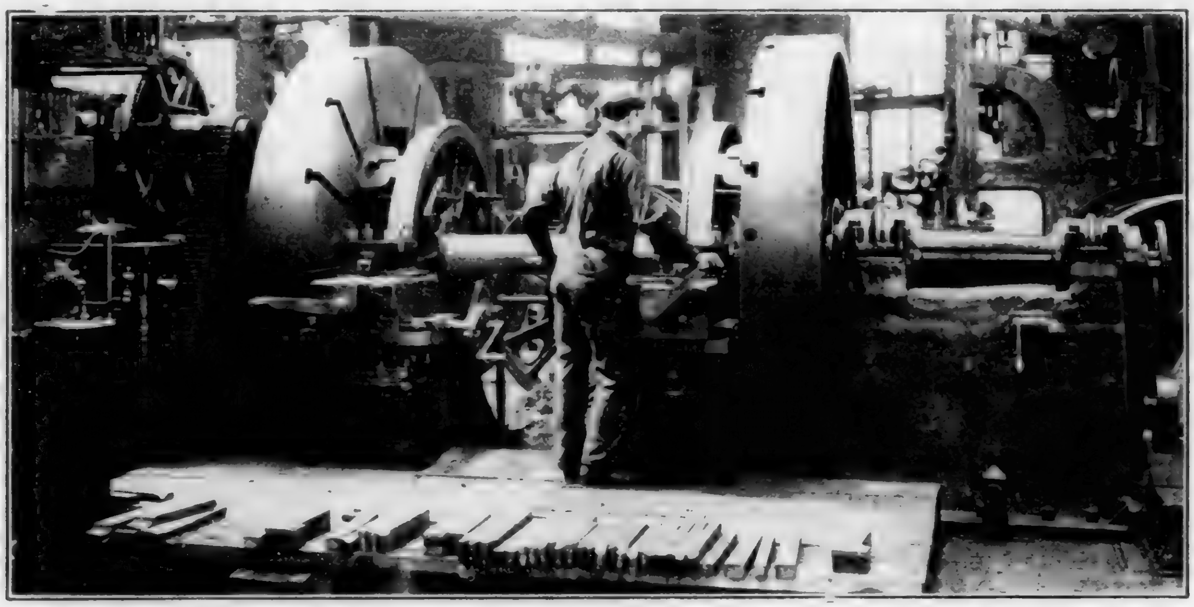
TURNING DRIVING WHEELS.

BY GUSTAVE GIROUX.*

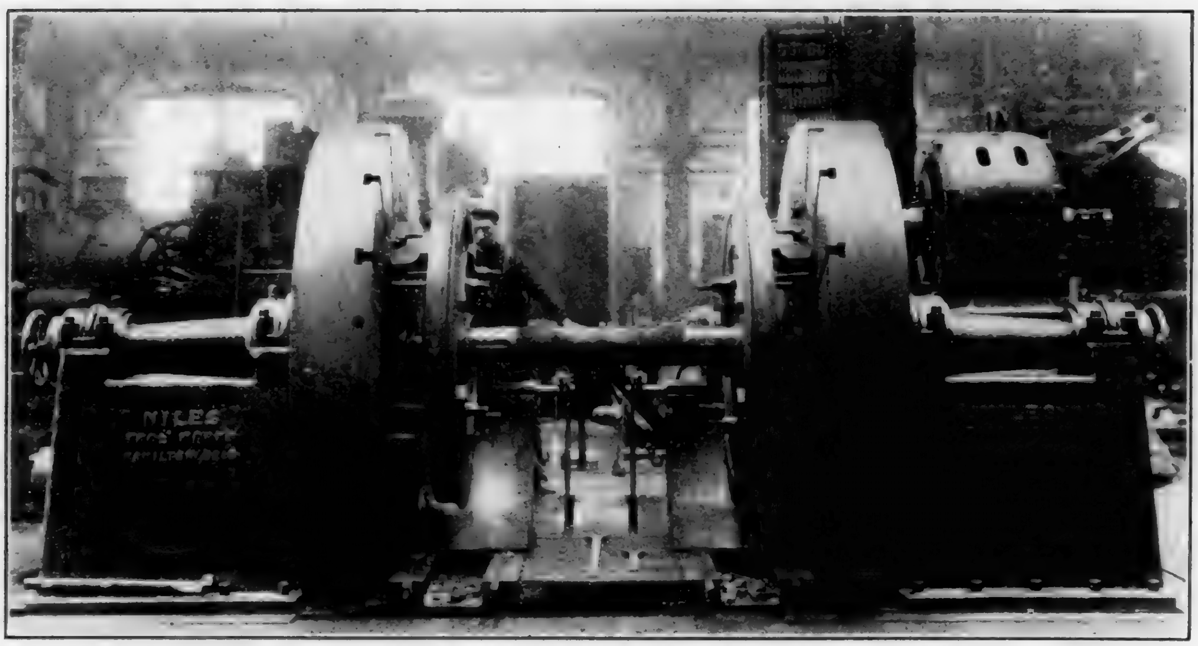
With a powerful up-to-date driving wheel lathe, high speed steel tools and a good organization it is possible to very greatly increase the output over that obtained under ordinary conditions. The reports which have appeared in the technical papers, from time to time, have been received by many with doubt, and it is the purpose of this article to explain in detail just what steps have been taken to increase the output at the Angus shops.

While there are a number of different makes of driving wheel lathes on the market there is more or less difference as to the amount of work which they can turn out in a given time; even the best one might be a disappointment to those who paid a high price for it if attention and consideration were not given to the conditions and organization surrounding it, for these are as important to the output as the machine itself and one is of little use without the other; perhaps it is just these two things which have caused disappointment because of the small output of some expensive and modern wheel lathes which have been installed.

The following statements are based upon the results obtained from a 90-in. driving wheel lathe, direct motor driven, weighing 100,000 lbs., which has been forced and has been in daily service for over twelve months and all it has cost for repairs during that time, both labor and material, would be covered by a ten dollar bill. Such a machine should be set upon a good solid foundation with the top of the base plate or bed practically level with the shop floor. The openings in the bed plate, or pit, should be covered so as to prevent workmen from being hurt by falling or getting caught in them, as well as to prevent the accumulation of dirt and cuttings, and thus keep the surroundings cleaner and more comfortable for the workmen.



FRONT VIEW WITH SHELF FOR TOOLS REMOVED IN ORDER TO PRESENT A BETTER VIEW OF THE MACHINE.



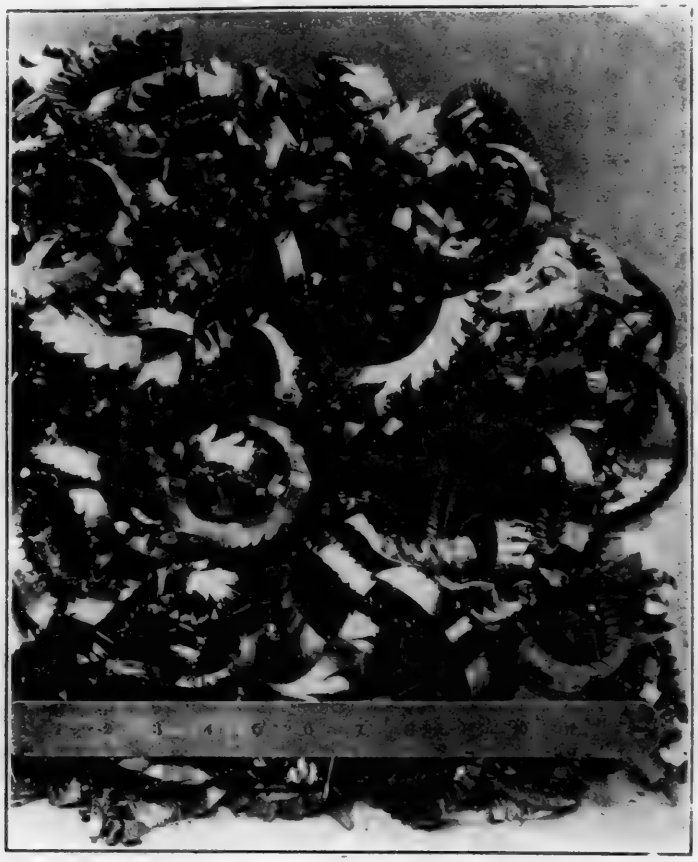
REAR VIEW, SHOWING SHEET IRON CHUTE FOR CUTTINGS.

90-INCH DRIVING WHEEL LATHE—ANGUS SHOPS.

Good sheet iron shoots with flanges should be fastened to the tool posts or rests so as to catch the cuttings as they fall from the tools, and slide them down towards the back of the machine where the helper can conveniently remove them without danger and without interfering with the operator or the running of the machine. On the front side of the machine, or the operator side, a good platform of conven-

*Canadian Pacific Railway, Augus Shops.

ient height and the full length of the machine should be built and upon it a shelf should be placed for keeping tools, etc. The height of this shelf should be about the same as the tool rests, for the convenience of the operator in handling the heavy tools to and from the machine with as little difficulty and exertion as possible. It is also important to have a full set of good wrenches. Two long handle wrenches should be kept, one on each side of the tail stock to loosen or fasten it,



CHIPS FROM ROUGHING CUT ON A PAIR OF DRIVING WHEEL TIRES.

one for the helper and one for the operator so that both can do their side at the same time and not have to strain themselves or get on their knees to tighten and loosen the tail stock when removing or putting a pair of wheels in the machine. The same wrench at the back of the machine can also be used by helper in loosening or tightening up driving dog clamps, while the wrench on the operator side can be used for the last or hard tightening down or loosening of nuts or studs of the clamps for the tools in the tool post; a shorter handle wrench should be kept for the convenience of the operator for the first or light tightening down or last or light loosening of the tool post stud nuts.

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The rate of speed at which the machine can be run depends upon the hardness of the tire; the average cutting speed is about 13 or 14 ft. per minute; it is, of course, necessary to slow down a little when striking hard spots. With soft tires higher speeds may be used. All roughing out of worn tires is done in one cut with an average feed of ¼ in. With this feed, if it is not thrown out on account of hard spots or changing of tools, a blind tire 6½ ins. wide is rough turned in 26 revolutions and about 16 revolutions are required for roughing out the tread of a flange tire 5½ ins. wide.

The different operations are done in so short a time and under such conditions that the attention of the operator is required at his machine all the time and leaves him no time to grind his tools without allowing an expensive machine and equipment to lie idle. The grinding of tools should be assigned to an expert tool grinder, who devotes all his attention to the caring for and grinding of all tools, not only for this one machine but for all other machines in the shop, and it is remarkable the credit which is due to such a man for keeping up the good cutting qualities of the tools, and thus

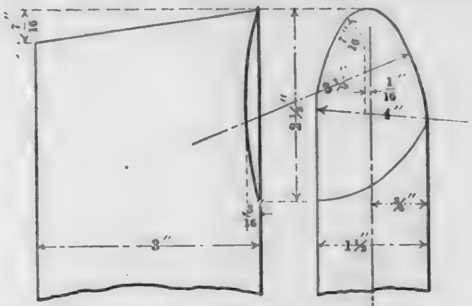

FIG.1 Rouging Tool, Left Hand

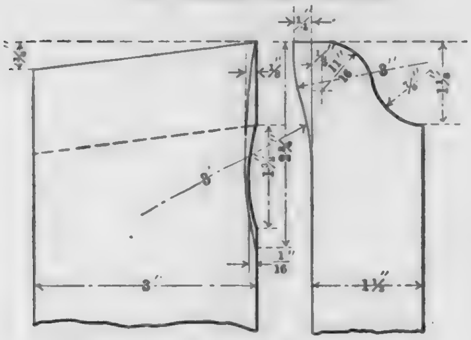

FIG.2 Inside Flange Tool, Left Hand

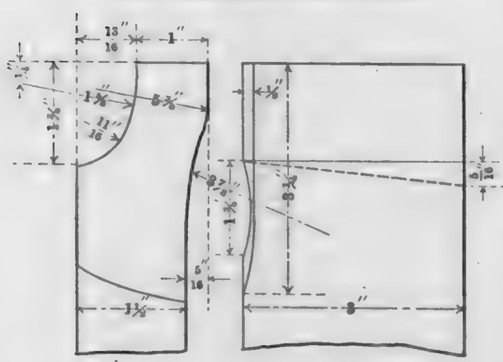

FIG.3 Outside Flange Tool, Right Hand

increasing the output. This man has under him, apart from his assistant, a man whose duty it is to carry the tools to and from the machines.. The expert not only looks after the grinding, but follows up the dressing of the tools done by the blacksmith and also sees to the tempering.

The selection of the proper kind of a man to put in charge of an expensive wheel lathe and equipment is important. He should be ambitious and must realize that the output of the machine will depend largely upon his efforts.

The handling of the wheels in and out of the machine is also of great importance; the time to do this will, of course, vary according to conditions existing in the different shops. A good travelling crane service is necessary to gain the best results. The time given here is for a shop with a travelling crane and is from the time wheels are taken from the cleaning track, which is 100 ft. away from the machine, until they are put into the machine and fastened ready to start the cut; this takes 11 minutes. The time it takes to loosen the wheels after being turned and to remove them from the machine to the storage track, which is 200 feet away, is four minutes. This is the time for the operator and his helper, and during that time the crane and its operator and slinger or crane attendant are used just long enough to carry wheels back and forth, but they do not help to loosen or fasten the wheels in the machine. The time it takes the operator of the machine and his helper to set or change the machine from a certain size of tire to another size is from 15 to 20 minutes.

The helper, in addition to assisting in putting in and taking out the wheels, cleans the axles and paints them with a mixture of white lead and lard oil (a pound of white lead to a pint of lard oil). The strains on the axle while the tires are being turned cause the oil to ooze out of cracks and defects in the axles, are thus located. The helper also keeps the machine and its surroundings clean and removes all cuttings to the scrap yard.

A machine operated under the conditions stated above is capable of turning out five pairs of old 84 in. driving wheel tires in ten hours or six pairs of old 47 in. driving tires in

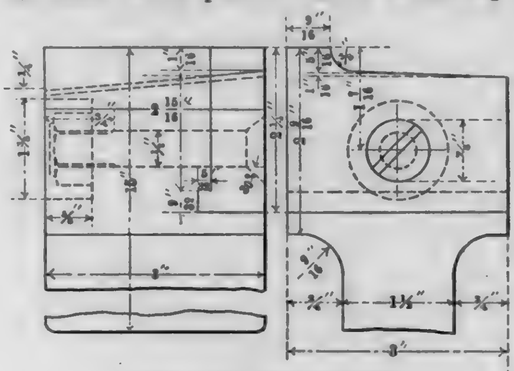

FIG.5 Forming Tool, Right Hand

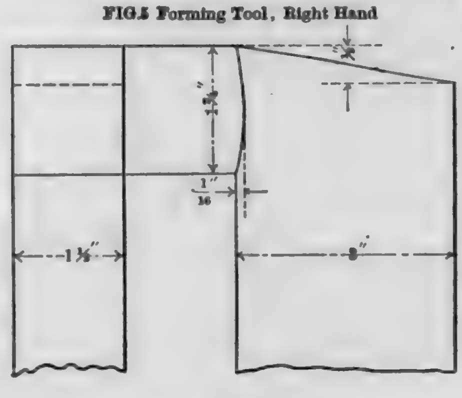

FIG.5

ten hours, or, in other words, will turn out in two days of 10 hours each, three sets of old 57 in. consolidation engine driving wheel tires. On one occasion after the machine was set, three pairs of 69 in. driving wheel tires with flat spots were turned in six hours, a 5/16-in. cut with a ¼-in. feed had to be removed to clean up the flat (hard) or skidded spots and this required, at some parts of the tires, as much as 7/16 of an in. in depth to be turned off. On another occasion three pairs of 63 in., wheels which were not badly worn but had been skidded, were turned in five hours, including the time to set the machine for that size of tire.

Below is given the time it takes for the different operations to turn both flange and blind tires complete.

	Flange.	*Blind.*
Make or Brand	Krupp*	Krupp*
Diameter	69 ins.	69 ins.
Width	5½ "	6 "
To pick up tires from floor and set in mach. ready for cut	11 min.	11 min.
To put roughing tools in and out and rough out tread	42 "	52 "
To put roughing tools in and out and rough out flange (both sides)	22 "	..
To put finishing tools in and out and finish tread..	10 "	15 "
To put finishing tools in and out and finish inside bevel	..	14 "

*All the driving wheel tires used on the Canadian Pacific are of Krupp steel and very hard. This should be kept in mind in comparing this record with that made in other shops.

To put finishing tools in and out and finish flange (both sides)	13 "	..
To put finishing tools in and out and finish outside bevel	9 "	16 "
To loosen wheels and remove them from mach. to floor	4 "	4 "
Total	111 "	112 "

In this case both pairs of wheels were from the same engine; the depth of the cut was 5/16 in. (full) and the feed was ¼ in., and a cutting speed of 13 ft. per min. was used which had to be slowed down over hard spots. It took five sets of roughing tools (10 tools) to rough out these two pairs of tires. This shows plainly what may be done on a modern wheel lathe with good equipment and facilities, for these figures are not of a record run but are of regular daily occurrence. If, in this case, tires had been soft and the roughing out could have been done with two sets of tools (4 tools) as is quite often done, the time could be cut down for both roughing and finishing.

The following is the result of a test made of the motor on this machine which at the time was an a. c. variable speed 30 h.-p., but which has since been changed to a d. c. variable speed 35 h.-p. motor: Diameter of tire 49½ ins., depth of cut ⅜ ins. feed 3/32 in., cutting speed 11 ft. per min., with all resistance cut out, maximum h.-p. 27.6. Diameter of tire 52 ins., depth 3/16 in., feed 9/32 in., cutting speed 16 ft. per min., maximum h.-p. 29.

The accompanying engravings show some of the roughing and finishing chips which were removed and will give an idea of the work such a machine is capable of doing, when operated under the conditions and with the organization and tool equipment described in this article. The use of the forming tools for finishing gives the wheels a remarkably smooth finish.

As a proof that it pays to look into conditions, organization and tool equipment for a new, modern, up-to-date machine it is very interesting to compare what the machine can do now with what it did at first when operated with what was at hand, or equipment from fairly good old machines and before improving the conditions and surroundings and by using the old style dogs driving on the spoke, and tools used on the older machine which had given good satisfaction in the past. Under these conditions the same operator worked as hard, if not harder, and the time it took him to turn a pair of 57-in. tires from the time he picked them off the floor with the travelling crane (which is the same now as it was then) and put them in the machine, turned and put them back on the storage track was as follows:

To pick up tires from floor and set them in machine ready for cut		24 mins.
To machine them complete	2 hrs.	45 "
To loosen wheels and remove them from machine to floor		11 mins.
	3 hrs.	20 mins.

The improvement of conditions, as outlined above, was made possible under the liberal policy advocated by Mr. H. H. Vaughan, assistant to the vice-president, and Mr. H. Osborne, superintendent of shops.

Superheat and the Steam Turbine.—The greater advantage of superheat with the steam turbine is well recognized, and steam consumptions of from 9 to 10 lbs. are frequently obtained on the Continent. The results of tests, several of which the writer has at hand, show that the records were made under actual operating conditions in the power plants, some of which, being made under a pressure of 175 lbs. and a superheat of 620 deg. F. at the throttle.—*Mr. Franz Koester, Street Railway Review.*

WALSCHAERT VALVE GEAR.*

The Walschaert valve gear was invented by Egide Walschaerts, master mechanic of the Belgian State Railways, about the year 1844, and for many years it has been commonly employed upon locomotives throughout the continent of Europe. American practice has, until recently, adhered, with few exceptions, to the Stephenson link motion, actuated by eccentrics. Experiments were made with the Joy valve gear, following the English practice, but this design has not been perpetuated in America. In the construction of locomotives for export, there has been a more or less continuous demand for the Walschaert gear. Its first use in the practice of the Baldwin Locomotive Works was in the year 1878, upon locomotives for the Mexico, Toluca & Cuantitlan Railroad. This gear has been growing in favor abroad, and, owing to its accessibility and the other advantages set forth in this article, has lately attracted wide attention from American engineers.

For large locomotives where the driving axles are of such diameter as to greatly increase the diameter of the eccentrics, the Walschaert valve gear is particularly useful. It is also found of essential advantage on locomotives having relatively small wheels and engaged in freight service, necessitating a high rotative speed.

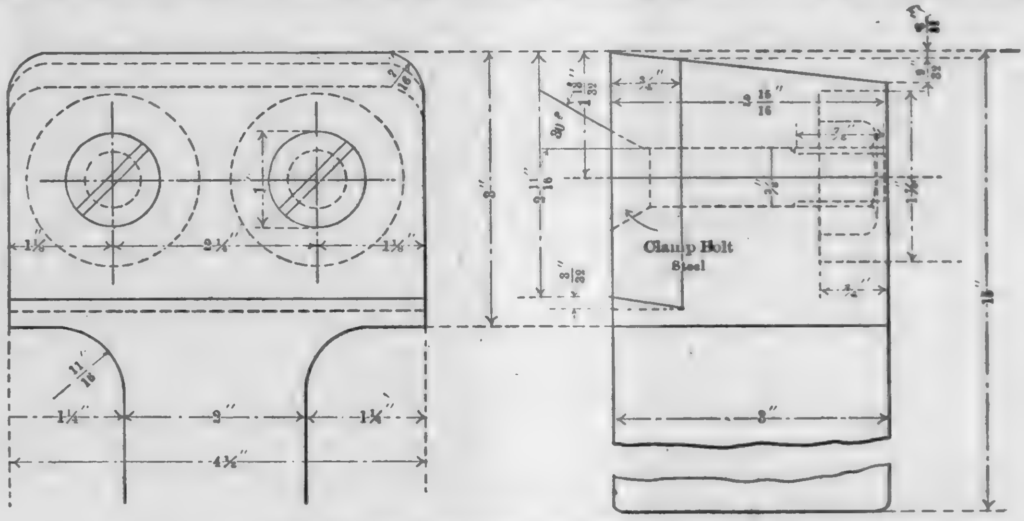

FIG. 4—TREAD FINISHING OR SCRAPING TOOL.

The size and arrangement of parts in a modern locomotive make it difficult for an engineer to properly examine the eccentrics and link motion when the engine is on the road, and breakdowns are more frequent on this account. The conditions of service also tend to make it more and more difficult for the enginemen to give the close inspection and care which is demanded in other branches of engineering service with high-speed machines. Stationary engine practice may serve as a guide to those responsible for the successful operation of locomotives, which are even to a greater extent than stationary engines, high-speed machines. With the Walschaert valve motion only a single eccentric or its equivalent is necessary for each valve. As usually constructed, it is found more convenient to substitute a return crank, thus reducing the pin bearings to the smallest possible diameter, so that they may be readily lubricated, and, owing to the small amount of work they have to do, give satisfactory service and absolute freedom from heating.

So far as the distribution of steam in the cylinders is concerned, the constant lead, which is a feature of this motion, is not considered objectionable, and it has some distinct advantages. Under such conditions it is possible to determine upon the amount of lead the engines should have at the most economical point of cut-off. This point determined, and so designed, it cannot be altered by any one in the shops or roundhouses. Another advantage is that it prevents valve

* From a Baldwin Locomotive Works pamphlet.

setters from attempting to produce results by moving the eccentrics into improper relations one to another.

The constant lead of the Walschaert motion prevents the sealing of the cylinders by the piston valve when the piston is at the end of its travel or approaching it; whereas with the link motion, either by derangement or excessive wear, the valve laps the ports at the end of the stroke, thus causing excessive compression and many other troubles. Another feature of the motion which appeals to the engineer, is the ease of handling the reverse lever when the locomotive is running at a high rate of speed.

GENERAL INSTRUCTIONS.

In setting the Walschaert valve gear it must be borne in mind that two distinct motions are in combination, viz.: the motion due to the cross head travel, and the motion due to the eccentric throw.

The crosshead motion controls the lead, by moving the valve sufficiently to overcome its lap, by the amount of lead in both front and back positions. The eccentric throw controls the travel and reversing operations. It will be seen that the movement due to the eccentric, without the crosshead motion, would place the valve centrally over the ports when the piston is at the extreme end of the stroke. The combined effect of these two motions, when the parts are properly designed, gives the required movement of the valve, similar to that obtained by the use of a stationary link. To reverse the engine, the link block is moved from end to end of the link, instead of moving the link on the block. This operation is accomplished by means of a reversing shaft connected with a reversing lever in the cab.

Walschaert gears should be correctly laid out and constructed from a diagram, as the proportions cannot be tampered with by experimental changes without seriously affecting the correct working of the device. The only part capable of variation in length is the eccentric rod, which connects the return crank with the link. This rod may be slightly lengthened or shortened, to correct errors in location of the link centers from center of driving axle which carries the return crank.

The eccentric usually assumes the form of a return crank on one of the crank pins—and its center is at right angles to the plane of motion, viz.: at 90 deg. to a line drawn from the point on the link at which the eccentric rod is attached, through the center of the driving axle. This eliminates the angular advance of the eccentric, and allows the use of a single eccentric for both forward and backward motion. The throw as specified must be correctly obtained, and great care taken that the position shown in the design be adhered to. The crank representing the eccentric is permanently fixed to the pin, and the slightest variation will be detrimental.

When the engine is assembled, the throw of the eccentric should be checked up by the specifications, and any error should be at once reported in order that the mistake may be rectified by either correcting the position of the eccentric, or by a change in the design of the other parts to compensate for the error.

In addition to the above instructions, the pamphlet contains special instructions for erecting and setting the valves and closes with the following simple additional check, which should be made to see that the valves are properly set:

Set one side of the engine so that piston is at its extreme forward position in cylinder, and check lead on admission port. In this position it should be possible to move the link block through its entire travel in the link, without in any way disturbing the movement of the valve. This operation should then be reversed, and the other side of the engine similarly tried with the piston located at its extreme backward position in the cylinder.

SOME OF THE ESSENTIALS IN LOCOMOTIVE BOILER DESIGN.

Mr. David Van Alstyne, mechanical superintendent of the Northern Pacific Railway, in a paper on the above subject read before the Northwest Railway Club on January 9, makes several suggestions tending toward the improvement of boiler design and the reduction of the large amount of trouble given by the boilers which are at present in operation. Mr. Van Alstyne has given this subject a great deal of study and the suggestions that he makes are the result of careful thought, guided by long experience.

The following extracts, taken from this paper, cover the main points suggested:

"Reliability and low cost of maintenance depend chiefly upon freedom of circulation around the firebox. Since circulation depends upon the head creating it and the size of the passages through which the water must flow from the barrel of the boiler to water legs around firebox, it follows that the greater the depth of firebox and the wider the water legs the more rapid the circulation. This depth should be obtained by maximum depth of throat sheet and not by raising the crown sheet at the expense of steam space."

"The greater the length of the firebox the greater the volume of water required to pass from the barrel of the boiler into the water legs, hence the side sheets and staybolts of a short firebox are less likely to give trouble than a long one. The tendency, therefore, should be toward a decided increase in depth of throat and width of water space and as short a firebox as is consistent with necessary grate area. The result will be an exceedingly heavy and bulky boiler at the firebox, necessitating the use of trailer truck which, it is likely, will eventually have four wheels instead of two."

"With reference to flues, considerable observation leads me to believe that a comparatively wide bridge, say, one inch or possibly more, is desirable for large boilers because of the greater stiffness of the flue sheet and probably better circulation between flues. But wide spacing does not cure leaky flues, which are the most difficult boiler trouble to control. The length of flue, quality of water and coal, method of firing and working injectors, weather and severe service, all have an influence on the leakage of flues, and this influence is, I believe, exerted chiefly through their effect on the size of the nozzle. Whatever causes, therefore, have the greatest tendency toward reducing the nozzle would be the most productive of leaky flues, and these I believe to be poor coal and severe service. So far as my investigation goes, the great majority of leaky flues are below the center line of the boiler, indicating that the short flames of highest temperature enter the lower flues. Hence the need for the greatest possible depth of firebox below the flues so that these hottest flames cannot reach them."

"Any other means of keeping the most intense heat away from the flue ends will have the same good effect on flue leakage, and recent experience with a combustion chamber which sets the flue sheet three feet ahead of the throat sheet has shown a marked decrease in flue leakage. Of utmost importance, however, is the care of boilers. The most poorly designed boiler is made better by more care, while the best designed boiler will not do well if neglected, and some of the important features in good care of boilers are regular and thorough washing out and blowing off, washing out and filling up with hot water, uniform boiler feeding and avoidance of working injectors as far as possible when the engine is not working steam, removal of broken staybolts promptly, and intelligent expanding of flues. Water treatment has done much to reduce boiler troubles, but it has its limitations and, in my judgment, should not be attempted until the possibilities of design and systematic maintenance have been exhausted."

"To sum up, it seems to me that the locomotive boiler in its fullest development will be much larger and heavier in proportion to the barrel than it is now. It is quite likely that it will be necessary to carry the overhanging weight back of the drivers on a 4-wheel truck."

"I think that it is not overdrawing it to say that no heavy

road engine should be built with weight on drivers more than 70 per cent. of the total weight, and the lower this percentage is the more reliable and efficient the engine will be, it being understood, of course, that as much of the dead weight as possible is put into the boiler."

An outline diagram of a Pacific-type locomotive was presented with the paper, which incorporates principles considered by the author to be of importance. This engine included a combustion chamber 6 ft. long ahead of the firebox and contained 374 2-in. tubes 16 ft. long. The water space in the throat was 8 ins. at the mud ring, and at the sides it was 6 ins. at the mud ring and widened to 12 ins. near the crown sheet. The combustion chamber was set 15 ins. from the barrel of the boiler at the bottom. This was a 22 by 28 in. engine having 78-in. drivers, giving a total of 150,000 lbs. weight on drivers and 250,000 lbs. total weight. The throat sheet was longer than usual, placing the grate as far below the combustion chamber as possible. The heating surfaces were, tubes 3,133 sq. ft., combustion chamber 121 sq. ft., firebox 213 sq. ft.; total 3,572 sq. ft. The grate area was 48 sq. ft.

4—6—0 FREIGHT AND PASSENGER LOCOMOTIVE—NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

10-WHEEL FREIGHT AND PASSENGER LOCOMOTIVE.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

The New York Central & Hudson River Railroad has just received fifteen 10-wheel locomotives from the American Locomotive Company, which were designed under the direction of Mr. J. F. Deems, general superintendent of motive power, and are adapted to handle either passenger or fast freight trains. The freight trains on the Hudson River Division are operated at a comparatively high speed, and in addition to this service these engines will probably be used to a large extent, especially during the summer months, in handling the heavy excursion passenger business. The following table presents a comparison between these engines and the Pacific type engines used on the New York Central, which have given excellent results.

			Advantage.	
	4-6-2	4-6-0	4-6-2	4-6-0
Weight, total engine	222,000	194,500	14.2%	....
Weight, total engine and tender	355,000	338,400	5.0%	....
Tractive power	28,500	31,000	....	8.8%
Grate area	50.2	54.93	....	9.4%
Total heating surface	3633	3306	9.9%	....

The 4—6—0 locomotives weigh considerably less but have a greater tractive power and a larger grate area than the 4—6—2 type. The latter type, however, has a larger heating surface, which probably accounts for their ability to carry heavy trains at sustained high speeds. The 4—6—0 type should prove very satisfactory for trains where long sustained high speeds are not required. The leading dimensions of these engines are as follows:

TEN-WHEEL FREIGHT AND PASSENGER LOCOMOTIVE—NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Fast Freight and Passenger.
Fuel	Bituminous coal.
Tractive power	31,000 lbs.
Weight in working order	194,500 lbs.
Weight on drivers	148,000 lbs.
Weight on leading truck	46,500 lbs.
Weight of engine and tender in working order	338,400 lbs.
Wheel base, driving	15 ft. 10 ins.
Wheel base, total	26 ft. 10½ ins.
Wheel base, engine and tender	59 ft. 2 ins.
RATIOS.	
Tractive weight ÷ tractive effort	4.77
Tractive effort x diam. drivers ÷ heating surface	647.
Heating surface ÷ grate area	60.1
Total weight ÷ tractive effort	6.27
CYLINDERS.	
Kind	Simple.
Diameter and stroke	22 by 26 ins.
Piston rod, diameter	4 ins.
VALVES.	
Kind	12 in. Piston.
Greatest travel	6 ins.
Steam lap	1 in.
Exhaust lap clearance	⅛ in.
Setting, line and line full forward motion	¼ in. lead at ¼ cut off.
WHEELS.	
Driving, diameter over tires	69 ins.
Driving, thickness of tires	3½ ins.
Driving journals, diameter and length	9½ by 12 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	6¼ by 10 ins.
BOILER.	
Style	Extended wagon top.
Working pressure	200 lbs.
Outside diameter of first ring	72⅛ ins.
Firebox, length and width	105⅛ by 75¼ ins.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	3½ and 4 ins.
Tubes, number and outside diameter	400 2-in.
Tubes, gauge and length	11, 14 ft. 11 in.
Heating surface, tubes	3,104.5 sq. ft.
Heating surface, arch tubes	26.4 sq. ft.
Heating surface, firebox	174.6 sq. ft.
Heating surface, total	3,305.5 sq. ft.
Grate area	54.93 sq. ft.
Exhaust pipe	Single nozzle, 5⅜, 5⅝ and 5⅞ ins.
Smokestack, diameter	20 ins.
Smokestack, height above rail	14 ft. 7 9/16 ins.
Centre of boiler above rail	115 ins.
TENDER.	
Tank	Water bottom with gravity fuel slides.
Frame	13 in. channels and plates.
Weight, loaded	143,900 lbs.
Wheels, diameter	36 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	7,000 gals.
Coal capacity	12 tons.

AN AUTOMOBILE TESTING PLANT.

Purdue University, at Lafayette, Ind., has recently installed an automobile testing plant. The design of the plant has been worked out under the general direction of Dr. W. F. M. Goss, Dean of the Schools of Engineering, assisted by Professors J. R. McColl and W. O. Teague. It follows lines similar to those of a locomotive testing plant, and constitutes a mechanism upon which an automobile of any type, whether steam, electric or gasoline driven, may be mounted and operated, and the power delivered, as well as the efficiency, may be determined.

The automobile, when mounted for testing, has its driving wheels carried by supporting wheels, which are upon an axle revolving in fixed bearings, the front wheels resting on a platform level with the top of the supporting wheels. Thus mounted, the automobile is held in its desired position by a connection with a traction dynamometer at the rear of the machine. A friction brake on the axle of the supporting wheels absorbs the energy delivered by the machine. A motor-driven pressure blower delivers air through adjustable piping for cooling the radiators of steam and gasoline machines, and a motor-driven exhauster takes air from a point near the exhaust of the machine, thereby freeing the laboratory of obnoxious gases.

(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE.

J. S. BONSALL,
Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT, } Editors.
E. A. AVERILL, }

FEBRUARY, 1906.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union. Remit by Express Money Order, Draft or Post Office Order.*
Subscription for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn St., Chicago, Ill.
Damrell & Upham, 283 Washington St., Boston, Mass.
Philip Roeder, 307 North Fourth St., St. Louis, Mo.
R. S. Davis & Co., 346 Fifth Ave., Pittsburgh, Pa.
Century News Co., 6 Third St. S., Minneapolis, Minn.
W. Dawson & Sons, Ltd., Cannon St., Bream's Buildings, London, E. C., England.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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Some railroad men say that they have no time to read technical papers. With all modesty this may be pronounced an unqualified mistake, because much valuable time may be saved by a proper study of technical literature. A young motive power officer was promoted chiefly because he did read the technical papers. He had found them valuable and made use of them in the office while occupying a position requiring long hours and constant application, but in the new position found that he was really too busy to read the papers as he did formerly. Therefore he adopted a plan which is worthy of the attention of others. He requires certain of his subordinates to read various journals, and to read them so thoroughly as to be able to place before him brifly the facts requiring his attention. Sometimes this was verbal and sometimes written, but in this way this official is sure to know of everything valuable which appears in print in connection with his work, and his method also requires the same knowledge on the part of others.

The effect of tonnage rating improvements on one of the western lines was recently investigated by an operating official, in a way to determine the results, which had been obtained by a careful study of the loading of locomotives. The purpose was to adjust rates previously put into effect, which in some cases were found to be producing delays in traffic due to over-loading. In some cases the rates were known to be slightly too low. This revision resulted in rather extensive changes on four divisions, by increasing some rates and decreasing others, the net result on one division was an increase of 19 per cent. in ton mileage; on the second division the increase was 9.1 per cent., on the third division 3.8 per cent. and on the fourth 27 per cent. The tonnage rates had in some cases been quite a little too high and in other cases were not changed. This experience indicates the desirability of an occasional review of this subject, because of the difficulty, if not impossibility, of determining tonnage rates at one time which would be good for all times and for conditions which are continually changing even if changing but slightly.

ANOTHER WORD TO COLLEGE MEN.

In recent discussions concerning college graduates and regular apprentices on our railroads much has been said about special apprenticeship. Those who believe that special apprenticeship of technical college graduates does not meet the present need are increasing in numbers. The question has risen as to how college men should be brought into railroad service, if not through special apprenticeship.

There are two ways to provide technically educated men in railroad service, one is to select promising young men from the ranks and provide technical education for them after having shown in practical experience their aptitude for railroad work. The other way is to take a young man into the service after graduation. If special apprenticeship is not the best thing for the latter, what then?

In the interest of these young men and in the interest of the roads the suggestion has been offered that the young men should begin in the shops, in the roundhouse or on a locomotive, at some point where men are wanted, that they should secure a position exactly as any other men secure positions by applying for it and being tried in order to ascertain their fitness. In the application for the position both the employer and the employee can well afford to forget the matter of education and its possible effect upon the qualifications of the applicant. When once in the service and standing squarely on his own feet, the education will help the young man in his career, and if he has selected his lifework wisely, and he is of the right sort, he will probably advance very much more rapidly than in special apprenticeship. This suggestion has been made in these columns before. It is not in any sense novel, but its reiteration seems necessary, because of the rather prevalent opinion that there is no other and better way for a college man to take up railroad work than that known as special apprenticeship.

SHOP EQUIPMENT AND OPERATION.

It is not difficult to interest railway officials in shop plans and shop buildings. Very valuable records of this portion of the shop subject are available, and it is comparatively easy to secure opinion and develop discussion of the relative merits of different arrangements. The fact, however, is becoming appreciated that many of the large important shop plants have been disappointing in the results of operation. Railroads are coming to realize that a modern shop involves a very large construction expense, but they have yet to realize that even of greater importance is the adequate development of the equipment and perfection of organization required to operate the large shop.

It is one thing to build a shop, and quite another thing to build it on a large scale in such a way as to decrease the cost of repairs. The matters of equipment and operation constitute a problem which comparatively few are able to discuss, for the reason that the shops, buildings and arrangements have themselves been so difficult to provide that there has not been sufficient time to properly consider equipment and operation. It is well to provide buildings sufficiently large and well arranged, and the time has now arrived for dealing with the remaining problem of what to put into the shops and how to manage them. This is a field to be tilled without the advantage of precedent, because only recently has the importance of commercial management and commercial production in railroad shops been appreciated.

It must be admitted that salaries in railroad shops have been conspicuously inadequate, but this is already beginning to change, and a brilliant future is held out to the men who are now prepared to take the responsibility for the operation of

the large modern shops in which so much money is invested. The railroads are not likely to be slow in securing adequate shop organization for plants which have cost them from one-half million to two million dollars. With the realization of what the large shops mean as an investment will come the means for utilizing them to the utmost, and it may now be confidently stated that young men who prepare themselves during the next few years to competently superintend railroad shops will be in greater demand than ever before. There are satisfactory indications that very soon superintendents of large shops will receive as high salaries as superintendents of motive power of moderate size roads received ten years ago.

STANDARD LOCOMOTIVES.

The adoption of standards for locomotive and car construction on large railway systems has developed a fact which is likely to become important. In the days of small railroads the individual ideas of the motive power officials were shown in a marked and distinctive way in the form of peculiarities in their cars and locomotives. While this tendency toward fads had its disadvantages, the locomotives and cars with these fads, and representing individual ideas, possessed the advantage of having the personal attention of the originators of the ideas and the personal interest of the officials responsible for them often led to a successful use of factors of design which in themselves perhaps did not possess great inherent value.

Now that roads have combined and the motive power questions are often decided by general officials the importance of standardizing is becoming appreciated. This standardizing movement is likely to have one effect to which attention has not yet been called. The danger is in adopting a standard of locomotive, or a series of standards, that these standards will be nobody's babies and that they will not represent the personal ideas or opinions of anybody, and no one on the road, not even the general head of the motive power department, will be the father of the design. It is much better that some one's individual opinions should be embodied in standard locomotives, even if those opinions be not the best, rather than that the standards should be the result of cutting and fitting, producing a weak, characterless combination of factors which represents what every one considers least objectionable. Such a standard as this would be inert in the sense that no single individual on the road is interested in its success because it does not represent any individual opinion and no one is prepared to stand up for it and make it successful. A standard locomotive under these circumstances is like one used in a pool, is like a shovel or a pick, and represents no individuality. It is something to be taken up and used and laid down again for some one else to take up and use.

Careful thought upon the possible effect of this leads to the conclusion that some one on every railroad must deal with the locomotive problem with a firm hand, and if any department of the road requires the hand of authority and responsibility it is the motive power department. The desired results will not be obtained until the present general superintendent of motive power on the large systems of roads is taken into the council of the higher officials and made a vice-president in charge of motive power. This official may then assume absolute authority and stand upon the results of his opinion as shown by the records. The locomotive is too important a factor in railroad operation to be successfully handled in any other way, and the time must soon pass when anybody and everybody may have a hand in influencing the design of locomotives. Much will be gained by appointing a vice-president in charge of motive power with the understanding that he should put into effect his ideas as to locomotive design. With a strong hand supported by wide experience and a knowledge of what is wanted and what is best he would be in an ideal position to do that which is needed

SHOP BETTERMENT AND THE INDIVIDUAL EFFORT METHOD OF PROFIT-SHARING.*

BY HARRINGTON EMERSON.

The employe wants as high wages as he can get. The employer wants his output to be as cheap as that of his competitors, for, if it is not, he will soon have to shut down his shop. Both desires are reasonable, and the problem is to reconcile them without injustice to either party. An absolutely clear understanding by both parties of the shop problem of to-day is necessary: the shop problem of to-day, not of years ago, when conditions were very different; not of years hence, when conditions no one can now foresee may prevail.

The worker cannot be expected to work for one employer for less pay than is paid under similar conditions for the same work by another employer. The wage-payer will not pay higher wages than the current rate, or than business conditions permit. There may be, however, quite a gap between the wages paid by competitors and the higher wages the employer would be willing to pay if it can be proved to him that it is to his advantage to do this. Wages above the current rate cannot therefore be agreed on in advance of performance, but should result from individual effort.

It is to be made plain to the employer that not by an increase of expense, but by a readjustment of expenditures, he can with advantage to himself give higher pay than the average; and it is to be made plain to the wage-earner that the receipt of higher pay must depend on his own individual character, skill and effort. Up to a certain point, competition and combinations can force wages up, sometimes generally, sometimes only locally and temporarily; but beyond this point there is a possibility of higher than the average pay, to be brought about only by recognition of the fact that the higher rate is to the advantage of both wage-payer and wage-earner. To illustrate the conditions of shop operation as they exist to-day, an example is afforded in the cost statement of a large machine shop in an eastern state.

COSTS OF OPERATION FROM JANUARY 1ST TO AUGUST 31ST, 1905.

Costs of Materials	$172,916.40
Wages paid to direct labor	$ 49,174.98
General Expenses	$ 90,698.54
	$312,789.92

OUTPUT 500 ENGINES, COSTING EACH—

		Per cent.
For material	$345.83	55.3
For direct labor	$ 98.23	15.7
For general expenses	$181.50	29
	$625.56	100

"Day wages" are less than one-sixth of the whole expense; "general expenses" more than twice as much as labor, and "material" more than half the total expense. The question was this: What can we do to reduce the cost of manufacture, so as to compete with our rivals?" To answer this question, the first step was, not to look at the plant, but to examine the accounts. In a plant a very small item may seem important, as when fault is found with some visible steam leak, but the big waste, as the condensation taking place in some buried pipe, is not noticed. But in the accounts, matters entirely overlooked by shop officials, yet making all the difference between success and failure from a business point of view, may at once become apparent. The condensed statement of cost of operation at once shows that materials are more important than general expenses, and these in turn are more important than labor costs. The three items of expense of this particular machine shop must first be more clearly defined.

COST OF MATERIALS.—This is the money paid out for materials bought wherewith to make the engines. It includes *all* the cast-iron, *all* the brass, *all* the steel, *all* the fittings, less the scrap value of material not used. If a high-priced casting is secured and spoiled in the machining, this becomes part of the cost. If a casting weighing 100 lbs. is paid for and machined down to 20 lbs., the whole 100 lbs. are included in the

* Prepared for distribution on the Santa Fe.

cost. If fittings are ordered and not used, if they are lost or stolen, if patterns are changed so that parts already cast can no longer be used, all these items enter into cost of materials. It is evident that very much material has to be paid for which never goes out on the finished engine.

Cost of Direct Labor.—Direct labor is the wages of those men who work directly on the machines to be sold. The labor of the machinist or of the fitter is considered direct labor, but the labor of the foreman or engineer, of the timekeeper, of the watchman, is not considered direct labor, but is taken care of as part of general expense. All direct labor does not, however, go into the machines that are sold. There is a very large shrinkage. If a casting is partly machined and has to be thrown away, the labor put on it is lost; if a man waits an hour for work, or for crane service, or studies an hour over a poor blue print, the money paid for his time is lost. If a man's machine breaks down, if his belts slip, if his tools are of poor quality, if the cast-iron is hard, if his machine chatters, if in consequence he takes twice as long a time as he would like to give to the work, half his time is lost, but has to be charged for in the cost of the engine.

General Expenses.—This includes many items, and first, wages of all employes whose time cannot be directly charged to a definite engine. The pay of all the officials, of all the bookkeepers and timekeepers, of all the foremen, of all the general force, as engineer, fireman, carpenter, millwright, watchmen, wipers, laborers, is part of general expense. Rent, insurance, taxes, repairs to buildings and machinery, depreciation of buildings and machinery, all small tools, belts, oils, and other supplies, all costs of power, heat, light, water, are some of the other items making up general expense. In the example given above, only the costs to the factory door are included, and not any allowance for advertising, for selling, for general offices and agencies, for bad debts, for finished machines that cannot be sold, etc. The question was not one concerning the management of the business, but solely concerning factory costs.

Increasing Costs by Decreasing Pay.—When factory costs are found to be too high, the usual plan is to propose a reduction of wages, chiefly because the payroll is the plainest and most insistent item of recurring expense, and also because any bookkeeper can reduce a payroll in a few minutes; but it takes long, intelligent planning and persistent effort to lessen the losses due to materials and to inefficient general management.

The results of reducing wages will first be considered in the case cited. If wages are reduced 10 per cent., the best men will leave; those who stay will be angry and discontented, becoming hostile and discouraged; and, those who are employed to take their places will be slow and unskilled. Less work will be done, and more material will be wasted and spoiled. It is safe to assume that for the same number of men and same amount of material 10 per cent. less engines will be turned out. More foremen will also be required to teach and direct the inferior men, and there will be no chance to save on taxes, insurance, and other similar items. The account will therefore stand:

Materials	$172,916.40
10 per cent. less wages paid to direct labor..	44,257.48
General Expenses	90,698.54
	$307,872.42
An apparent saving of	4,917.50
	$312,789.92

But if we consider output, another story is told.

Output 450 Engines, Costing Each:

		Per cent.
For Materials	$384.26	56.2
For Direct Labor	98.34	14.4
For General Expenses	201.55	29.4
	$684.15	100

Put the two results side by side:

Cost before wages were reduced.	Per cent of direct labor.	Cost after wages were reduced.	Per cent of direct labor.
$625.57	15.7	$684.15	14.4

By reducing the amount paid direct labor the manufacturer has reduced his output, and his other costs for each engine have increased $58.58, or nearly 10 per cent. This is evidently not the way to go about it, as it harms not only the wage-earner but also the wage-payer. As any poor method must harm both employer and employe, so a good method should benefit both employer and employe; and there is such a method.

How to Lessen Costs by Increasing Pay.—The desirable method is the one which lessens the cost of production to the employer yet increases the reward of labor. One of the names given to it is "shop betterment." Shop betterment is based on careful examination of details, of methods, materials, machines and men employed in shop production, and on the elimination of all unnecessary wastes and losses of material or of effort and time. Shop betterment takes into account the three items of expense and the final cost of each engine.

Cost of Materials	$172,916.40
Wages to Direct Labor	49,174.98
General Expenses	90,698.54
	$312,789.92

Output 500 Engines, Costing Each:

		Per cent.
For Material	$345.83	55.3
Direct Labor	98.35	15.7
General Expense	181.40	29
	$625.58	100

The largest of these items is cost of materials; the smallest, wages of direct labor. It ought to be easier to save $5,000 out of $172,916 than to save $5,000 out of $49,174. Moreover, a manager may have trouble on his hands if he tries to cut direct labor, while no one should object if he can save some of the wastes in his materials.

Reducing Costs of Materials.—In materials much can always be done. Designs can be bettered so as not to require so much or so expensive materials. A light, high-speed stationary engine will furnish just as much power as a heavy, slow engine. Patterns can be made a little closer to finished sizes and castings be specified of soft, sound iron, and be pickled before being machined, thus lessening the time required. By these means 5 per cent. might be saved on material, and 5 per cent. on $172,916 is $8,645.80; while 10 per cent. reduction in wages would amount to only $4,917.50.

Reducing General Expenses.—The next item to look at is general expenses. This might be reduced somewhat if fewer foremen, watchmen, timekeepers and bookkeeprs, tool dressers, repair men, were required; and fewer of these men are required for good workmen than for poor. The best way, however, to reduce the percentage of general expenses is to increase output, as the larger part of general expense remains the same whether 10 or 1,000 engines are made. To increase output the employer puts his machines in good repair, lines up his shafting, renews and maintains his belting, puts in emery wheels, stops up the air and steam leaks, increases his air pressure, puts up better drawings, supplies better small tools, dresses and tempers and grinds them better, secures jigs and special devices, and makes it possible for the worker with less exertion than formerly to turn out considerably more work.

Reducing Costs Through Co-operation.—The employer who aims to reduce costs by saving in materials and in general expenses first puts all his equipment and supplies in good condition, and then goes to the workman and tells him that if he will co-operate to cut out unnecessary losses and wastes, if he will make good use of the better facilities afforded him, it will be possible to increase the amount paid him. Let us assume that on the average the increase of pay amounts to 20 per cent., and that the output is increased 20 per cent., but that materials increase only 10 per cent., and general expenses not at all, how does the account then stand?

Materials	$190,208.04
Direct Labor	$ 49,174.98
Average Increase, 20%	$ 9,835.00
General Expense	$ 90,698.54
	$339,916.56

Output of 600 Engines, Costing Each:

		Per cent.
For Material	$317.01	56
For Direct Labor	$ 98.35	17.4
For General Expenses	$151.16	26.6
	$566.52	100

The employer pays his men 20 per cent. more, and by all sorts of shop betterments, which cost a great deal to install and maintain, he enables them to obtain 20 per cent. more output from the machines in the same time and without any more exertion to themselves; yet, owing solely to the cutting out of useless wastes, the output costs 9 per cent. less. This 9 per cent. is the employer's gain. The method is one that benefits both wage-payer and wage-earner. Each, independently, has worked to reduce losses and wastes of materials, of supplies, of operation, of time, and they both share in the gain. This system of profit-sharing has been rightly called

THE INDIVIDUAL EFFORT SYSTEM,

because it depends on the individual effort of both employer and employe. The former does not arbitrarily reduce wages, for he has found a better way to economize, and the latter does not arbitrarily make demands for increased pay, for he has already increased his own pay far above the rate any employer would grant. Irrespective of the individual effort gain, they both, at the time the wage-earner is employed, enter into an agreement or contract as to regular wages. This contract wage may be changed from time to time as conditions change; but whether it rises or falls, it has nothing to do with the profit-sharing plan of individual effort. The employer must exert his individual effort to make all conditions of production as good as possible, and these include the comfort and well-being of his employes. The employe must exert his individual effort to do his best under the conditions afforded.

The Pay for Individual Effort.—As the method is one of individual effort, a practical way must be found of rewarding the individual worker in addition to and regardless of regular contract wages. The method adopted has long been in use in paying engineers and firemen on the railroads of the United States. It was thought that no better method could be devised than one adapted from such a model, and satisfactory to men of such skill and standing among the employed. In operating trains the employer makes the roadway, maintains the track, furnishes the engines and trains, installs the system of signals, makes out a time schedule, appoints a dispatcher, and then gives the train to its crew. The ability to make the schedule depends on the conditions furnished by the employer and on the diligence and skill of the crew. The latter are expected to make the schedule, but if they fail through any fault not their own, they receive time pay although the train stands still; and if for any reason they make extra effort, run more miles than the schedule calls for, they are paid for the extra miles.

As far as possible this system has been adapted to the machine shop. A schedule is made out, a reasonable standard-time is set, such as any skilled man ought regularly to make, a schedule on which any good foreman ought to insist. For doing work in standard time the wage-earner receives 20 per cent. increase of pay above the hourly rate. He is paid this extra 20 per cent., not to work beyond reason, but to use his brains as well as his hands, to be his own foreman, to help keep conditions as they should be, to assist the employer in maintaining high efficiency in tools and machines.

If for any cause whatever he does not maintain schedule standard time, he is still paid an extra amount until time-and-a-half has been used on the job. If he falls below time-and-a-half, he still receives his regular hourly rate, which is never interfered with. If, however, he does better than standard time, then he is given all the gain due to his own time. If standard time is 1 hour, if the rate is $0.25 an hour, if the extra pay is $0.05, making a total of $0.30, then, if the work is done in one half-hour the wage-earner is paid $0.30 for one half-hour's work, or at the rate of $0.60 an hour. If, however, he takes 2 hours on the job, he receives $0.50, or at the regular rate of $0.25 an hour. This shows why it is possible by unusual and extraordinary effort to earn a large extra amount.

This method of profit-sharing, of rewarding individual effort of both employer and employe, is utterly different from piecework, with which those who have not investigated it have confounded it. In day work the employe is paid for his time, and he gets the same wages whether he works extraordinarily well, badly, or not at all. In piecework the employe is not paid for time, but for output. He takes all the risks of conditions over most of which he has no control, and if he seems to make too high wages the rate is often cut. Under the individual effort system the wage-earner is guaranteed his regular hourly rate irrespective of output. It is the foreman's duty as well as his own to avoid unnecessary delays. His hours are definite both as to beginning and end; his nights and Sundays are his own, and overtime being recognized as an evil to both employer and worker, it is eliminated as far as possible, the employer being forced to pay time-and-a-half for every extra hour. Wage-earners have contended for shorter hours, yet with opportunity to earn regular rates of wages. Under the individual effort system a man can work eight hours, yet earn as much as he formerly earned in ten hours.

No Piece Rate.—Because there is no rate by the piece, men may receive the same increase above normal wages for turning out different amounts of output. Each must do well, and this is all that is asked. One man may have a good machine, another a poor one; one has a hoist, and the other none; so the latter is allowed twice as much time and twice as much pay for his output as the former.

Cutting the Rate—But what is to prevent the employer from cutting the rate? Cutting *what* rate? The day rate has nothing to do with the individual effort reward, and if the day rate is cut the worker can resist, as he has always done. Cutting the standard time? The standard is a fair time, adapted to conditions. If conditions change for the worse, the schedule time should be extended just as time cards of trains are lengthened when the track conditions are bad; and if the conditions are improved the schedule is shortened just as time cards are shortened when all track conditions are bettered. If a man has been working on a $1,000 wheel lathe on which the best he could do was a pair of drivers in four hours, and he is given a $10,000 wheel lathe on which he can just as easily turn the same pair of drivers in an hour and a half, of course he receives a different schedule; but it is still as easy, probably easier than it was before, to earn the 20 per cent. extra each hour. The worker is paid 20 per cent. extra, not for doing so much work, not for turning out so many pieces, but for making good use of the conditions, whatever they are, and making his head save his hands.

He wants to know, however, what is to prevent the employer from arbitrarily reducing standard time so that it will be impossible to earn 20 per cent. extra. The answer is that self-interest stands in the way, the self-interest of the employer, and this is the strongest protection of the worker. Nothing compels the employe to try to make standard time. If he does not think he is treated fairly, he will not put forth the same effort, and the employer loses far more than he does. The schedules are intended to be as fair as they can be made. If found not to be fair, they should be revised and adjusted in the interests of both parties. For example: Standard time of turning locomotive drivers, four hours; man's rate, $0.30; extra pay per hour, $0.06; general expenses per hour, $0.60.

The Cost at 4 Hours:

Wages	$1.20
Individual Effort Reward	.24
General Expenses	2.40
Total Cost	$3.84

The employer reduces standard time to three hours, and the employe drops back to five hours. He can just as well do this, for he would make nothing extra at his former time of four hours.

Total Cost at 5 Hours:

Wages at $ .30	$1.50
Individual Effort Reward	—
General Expenses	3.00
Total Cost	$4.50

Because standard time has been cut, the employer loses $0.86 and the wage-earner loses $0.30. The proverb says any one can lead a horse to the trough, but it takes a wise man to make him drink. The employer can do his share, but all his trouble and expense will be in vain unless he can induce the wage-earner to co-operate; and the cheapest, easiest method to secure and maintain co-operation is to offer an attractive increase of pay. Under no other system can the employe so effectively protect himself.

Standard times for each operation are determined by a careful study of all the conditions and a try-out, itemized in minutes and seconds. The try-out is not with stunt or pace-making labor. The economies are effected by cutting out wastes, not by demanding extraordinary or unreasonable output. Is it the practice to discharge men who cannot reach standard time? No. If a man cannot reach standard time, it is for one of three reasons: either standard time is too low, in which case it is corrected; or the machine and equipment conditions are not right, and should at once be improved; or the worker does not know how, is not up to the machine operation, in which case he is changed to some other place. If a worker deliberately makes up his mind that he will not give a fair return for his wages, if after changing him around several times and giving him several chances to accomplish what others easily and regularly do, if such a man not only does not reach standard time but cannot get out the work in twice standard time, he ought not wait to be discharged, but have enough decency to take his time and then take up some other occupation more suited to his temperament.

Does the individual effort system result in discharging old men because they cannot attain the times of younger and stronger men? This question provokes a smile. The 20 per cent. extra pay is given, not for hard work, but for head work. The younger men may not know it, but the older men are wiser, and if they do not have the bull-strength method of accomplishing, they supplement energy with intelligence in running a machine or planning an operation. They make few false moves, they take the stitch in time, they know that a carefully tempered and ground tool set at exactly the right angle will cut easier, faster and longer than a tool selected and set without the knowledge that long experience alone gives. Young men by driving their machines at an extraordinary rate have earned extraordinary pay, but it is the older men who in the long run will draw the most extra pay, who turn out the most reliable and satisfactory results. Some of the most productive workers are men between 50 and 60: productive not because they use their muscles, but because they use their heads.

In certain shops where this system is in operation, the most valued workers are men who have been with the company in these same shops for fifteen to twenty years, and under the individual effort system they are earning higher pay than they ever earned before, even in their so-called prime, and there is no reason why a good man should not earn day wages and individual effort reward until he is 70 years old or more. No portion of the gain made by workers is given to any foreman, nor a cent of it to any betterment-force employe. Foremen are paid by the day or month, and whatever extra they earn is based on the assembling of work on time and on efficient support given the workers.

The individual effort method of increasing the reward of the wage-earner includes all that is best in other methods, and attempts to exclude all that is objectionable. Its good points are summed up as follows:

1. The standard time set is reasonable and one that can be reached without extraordinary effort, is in fact such time as a good foreman would demand.

2. An extra reward of one-fifth of the regular wages for the operation is given to whoever makes standard time.

3. Extra compensation above the hourly rate is paid even if standard time is not reached, although this extra compensation diminishes in percentage above standard time-and-a-half.

4. If longer than time-and-a-half is taken, the regular day rate is paid. Of this, the wage-earner is also sure.

5. Standard time is carefully determined by observation and experiment, and is only changed when conditions change.

7. The arrangement is one of mutual benefit to both parties—of increased earning to the worker, of increased saving to the employer.

8. The employer loses more than the wage-earner if schedules do not encourage co-operation.

9. The wage-earner, working on a schedule, becomes in a large degree his own foreman.

10. The wage-earner determines his own earning power, and by co-operating to cut out wastes increases his own value.

The direct results of shop betterment and individual effort are:

FOR THE EMPLOYE.

To shorten the hours of labor.
To enable each man to determine his own earning capacity.
To increase earnings.
To do away with overtime.
To make him self-reliant.
To add to his value as he grows older.
To add to his comfort and safety in the shop.
To harmonize relations with the employer.

FOR THE EMPLOYER.

To decrease the cost of production.
To lessen the delays on each job.
To lessen careless wastes and breakages.
To increase the output for the same investment of capital.
To secure a higher class of employes.
To harmonize relations with employes.

This individual effort reward method of adding to the gains of both employer and employe has been recently adopted in the shops of one large railroad company, but is not yet in use by any other railroad or private concern. It is essentially a method of co-operation and profit-sharing. However much the employer may better conditions, he cannot materially reduce expenses unless the wage-earner co-operates; and however hard the wage-earner may work, he cannot increase his pay unless the employer provides the right conditions. In justice to both parties, all schedules and changes should be matters of written, not verbal, record, and while schedules can be put provisionally into effect, it should be understood that approval is not authoritative until signed by the high official who has jurisdiction over such matters. All concerned, whether workers, foremen, timekeepers, or record clerks, can, by inquiry, find out all about the conditions. It is the worker's business to know what schedule he is working under, and that its heading tallies with the work he is doing. Occasional disagreements between employer and employe seem natural, but not a conflict, since both look to the same shop and the same operations for their living, and also because there should be no conflict about creating value out of what is usually destroyed, about eliminating gross wastes which profit neither employe nor employer. The saving is so large as to afford both employe and employer gain far above the average, in which each, with *fairness*, unspoiled by *favoritism* or *subserviency*, and without *drudgery*, can share in proportion to individual efficiency.

STATUE OF MATHIAS BALDWIN.—A statue of Mathias Baldwin, founder of the Baldwin Locomotive Works, has been presented to the city of Philadelphia by officials of the firm, and will be unveiled in the spring. It cost $18,000, and will be placed in Fairmount Park. An inscription on the statue reads: "His skill in the mechanic arts, his faithful discharge of the duties of citizenship, his broad philanthropy, unfailing benevolence and devotion to all Christian work, placed him foremost among the makers of Philadelphia."

The report of the Board of Railroad Commissioners of the State of New York shows that for the year ending June 30, 1905, but two passengers out of 97,060,279 were killed from causes beyond their own control; 12 were killed by their own misconduct or incaution, and 1 because of intoxication.

SIMPLE 10-WHEEL LOCOMOTIVE WITH YOUNG VALVE GEAR.

DELAWARE & HUDSON COMPANY.

The Delaware & Hudson Company recently turned out from its Green Island shops four ten-wheel culm burning locomotives, built after designs worked up in the motive power department.

These locomotives, one of which is illustrated herewith, have 21 by 26-in. cylinders and 63-in. drivers. They weigh about 173,000 lbs. total, of which about 75 per cent. is on drivers. The boiler is constructed for burning culm, and has a firebox about 10 ft. long by 8 ft. 6 ins. wide, giving a grate area of nearly 85 sq. ft. The grate is supported on water bars. The fireman's cab has been given special attention, and is all part of the locomotive; the hood on the tender usual for this type of engine being omitted, and the roof of the cab having a long extension to take its place.

10-WHEEL LOCOMOTIVE WITH YOUNG VALVE AND GEAR—DELAWARE & HUDSON COMPANY.

The table of dimensions, weights, etc., below will show the features of these locomotives, which are, in general, the design which experience has shown to be satisfactory for this class of service.

The Young valve gear, used on two of these engines, is an adaptation of the Corliss principle for locomotive use. It employs the rotating valves operated from a wrist plate, which is oscillated by a connection from the rocker arm. Back of the rocker arm the ordinary Stephenson link valve gear is used without change. The principal feature in which this gear differs from the Corliss is that one valve is used for both admission and exhaust control, and that the wrist plate pivot is movable. This pivot is fastened to the end of one arm of the bell crank, the other arm of which has a direct connection to a short crank arm on the reverse shaft. The fulcrum of this bell crank is rigidly fastened to the cylinder casting.

The special features concerning steam economy which this valve introduces are that a constant steam lead is maintained at all points of cutoff, and the exhaust lead is increased as the cutoff is shortened. The valve gives a very quick cutoff, preventing wire drawing at this point, and in the same manner opens readily, giving a full port opening for the admission. The increasing exhaust lead gives an earlier exhaust opening and a delayed exhaust closure when the locomotive is working at high speed on a short cutoff. All of these comparisons are made with the ordinary slide valve. The design of the gear permits, by arranging for two passages, of a larger port opening than would be possible with either a slide or piston valve. The area of the steam ports in this locomotive are 32 sq. ins., as compared with 24¾ for a slide valve engine of the same type.

The illustrations given herewith show the mechanical features in a clear manner. It will be seen that the valve chambers and all passages connecting therefrom are included in the cylinder casting, there being two valves for each cylinder, each set directly above the port entering the cylinder, being 11½ ins. in diameter 22⅛ ins. long inside the bushing, and having their axes at right angles to that of the cylinder. It will be noticed that there is a supplementary passage extending from the top of the valve chamber, around the outside and joining the one going from the bottom of the chamber directly to the cylinder. This allows the steam to have two passages, and with the same distance of port opening gives a length equal to twice the length of the valve strip; exhaust steam also follows the same path. It will also be noticed that the passage of the steam to and from the cylinder is more direct than that usually found in the slide or piston valve. The back head of the valve chamber is cast integral with the cyl-

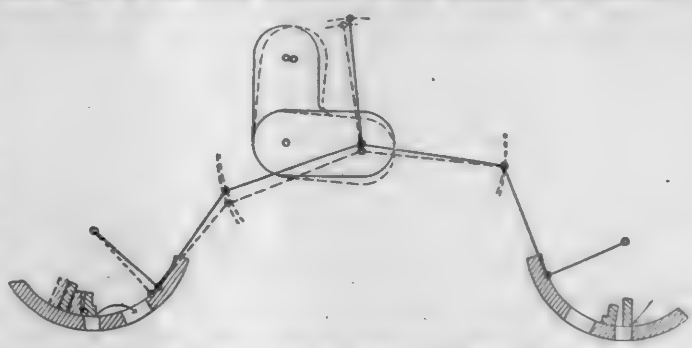


DIAGRAM SHOWING THE EFFECT OF MOVING WRIST PLATE FULCRUM ON EXHAUST LEAD—YOUNG VALVE GEAR.

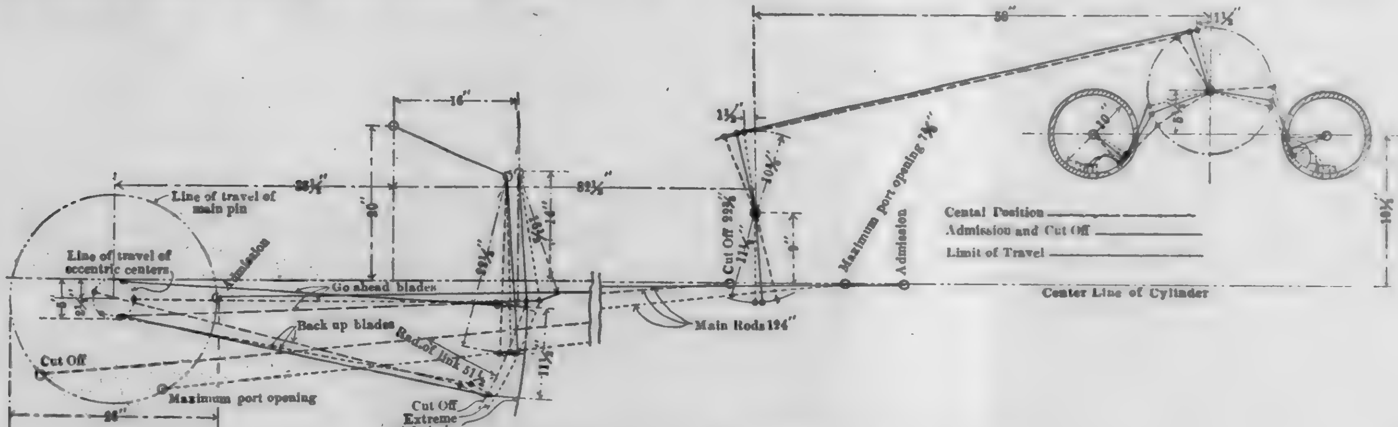
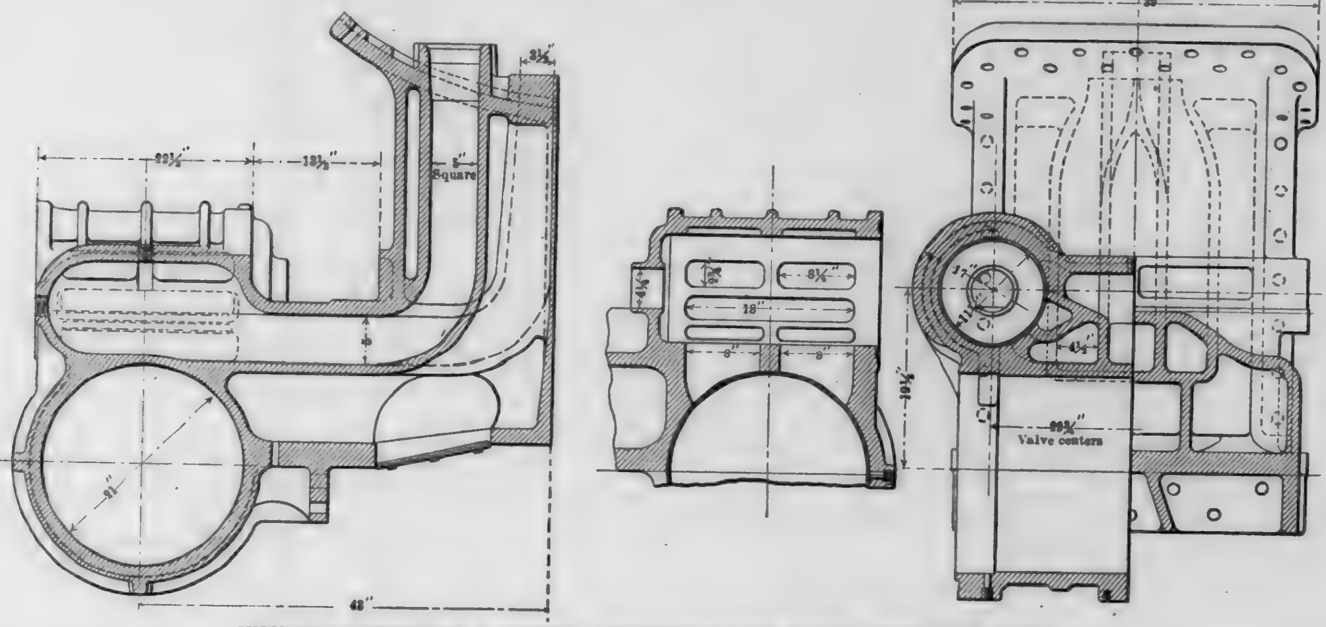


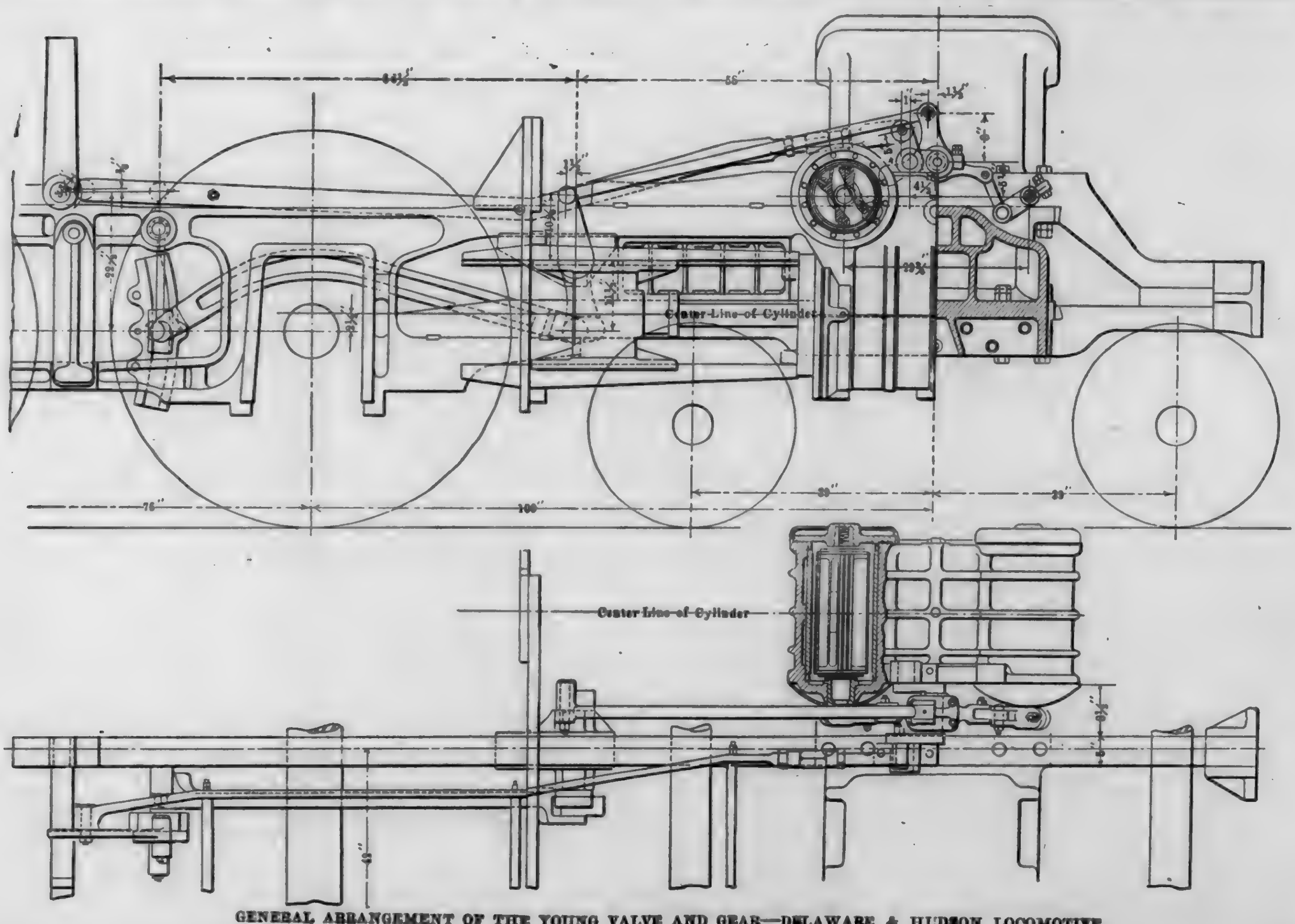
DIAGRAM SHOWING OPERATION OF THE YOUNG VALVE GEAR.



CYLINDERS—DELAWARE & HUDSON LOCOMOTIVE WITH YOUNG VALVE AND GEAR.

inder casting, and only has an opening for the valve shaft, the front head, however, is removable.

The construction of the valve itself shows plainly in the sectional views. It is constructed of cast iron, of a light section and of peculiar shape; the packing strips, of which there are two on the controlling side, and one narrow one in the wall separating live from exhaust steam, are of the same design used in the Richardson balanced valve, having light flat springs to hold them against the chamber wall. There are also packing strips extending around the ends between the longitudinal strips for preventing leakage at this point. These are separate pieces and abut the ends of the other strips. The stem, which is of steel, is fitted into one end of the valve and fastened with four dowels. This stem extends through the inner chamber head and carries the arm through which the valve is operated. The method of making a steam-tight joint at this point is interesting and effective. There is a brass bushing fitted into the casting and turned to a taper of ½ in. in 12 ins. on the inside for a distance of 2¼ ins. A ¼-in. lip is formed on the outer end, against which the shoulder of the valve stem, which is turned to make an exact fit in this bushing, rests. The valve stem also rests against the inner face of the bushing where there are a number of grooves cut to allow a small amount of steam to pass around the stem and



GENERAL ARRANGEMENT OF THE YOUNG VALVE AND GEAR—DELAWARE & HUDSON LOCOMOTIVE.

lubricate the bearing. On the opposite end of the valve the bearing is made in the head and steam pressure between the head and valve holds the valve up against the shoulder of the inner bearing. A coil spring holds it in place when steam is shut off. This method, which employs no packing of any kind and needs no attention as to lubrication, has proved to be very satisfactory. The coil spring rests against a steel button, which prevents the spring affecting the rotary action of the valve.

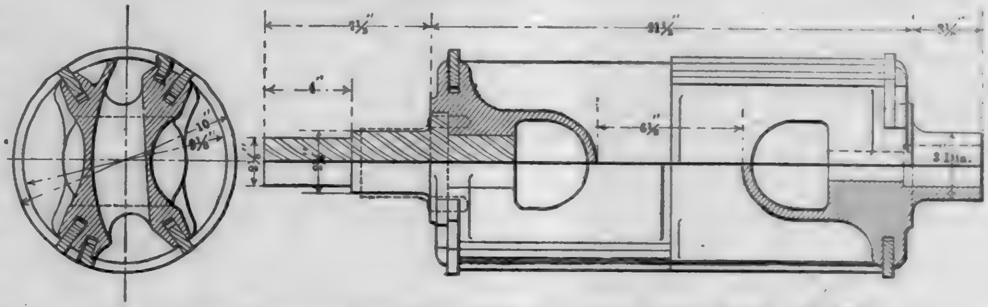
The arms on the valve stem are securely keyed, but in such a manner that they are easily removed when it is desired to remove the valve from the chamber. These arms connect to the wrist plate through short links. The wrist plate, as above mentioned, has a movable fulcrum operated from the reverse shaft. All of this construction is heavy and rigid. The connection from the bell crank to the reverse shaft is direct and, in this case, is by two rods fastened to the reverse shaft arms a short distance from the shaft and cross braced for stiffness. This connection has a nut for adjusting its length. Connection from the rocker arm to the wrist plate is through a rod, very similar to the ordinary valve rod, which is not adjustable. Reference to the outline diagrams showing the movement of the valves will make its operation clear. The one showing the movement caused by the moving of the bell crank illustrates how, by moving the fulcrum of the wrist plate, the events connected with the admission of steam are undisturbed, while those connected with the exhaust are varied.

This type of valve gear was first placed upon two locomotives on the Chicago & Northwestern, one of which, a large, high-speed Atlantic-type locomotive, went into service with this valve gear on September 26, 1903, and was operated in the pool with other engines of the same type having piston valves. In that service, this engine showed itself to be capable of more reliable service and was able to handle heavier trains on the same schedule than were the other engines. The matter of diminished tire wear was especially noticeable, and the wear on all the valve parts was also very small. The engine was taken into the shop on April 25, 1905, after having run 122,000 miles, and it was found that the greatest wear on the valve gear was in the wrist-plate bearing, which is so constructed that it can be closed up as wear develops, and at that point it was but 1-32 of an inch loose. The eccentrics were but 1-64 of an inch out of round with but one exception, which was 1-32 of an inch out. The wear on the valve bushings and packing strips was negligible. This locomotive was again put into service after repairs, and at the present time is performing satisfactory work.

Of the two Delaware & Hudson locomotives, one has been in service at the present writing for over two months and the other for about thirty days. Both are reported to be giving excellent satisfaction in both fast and slow service. Three other railroad companies are at the present time about to place locomotives in operation equipped with this gear. The general dimensions of the D. & H. locomotive follow:

SIMPLE TEN-WHEEL LOCOMOTIVE—DELAWARE & HUDSON CO.

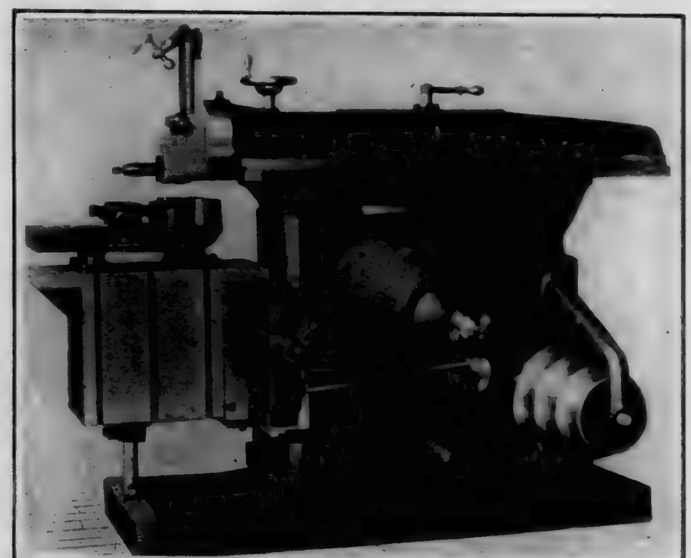
GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Fuel	Culm.
Tractive power	31,000 lbs.
Weight in working order	173,000 lbs.
Weight on drivers	130,000 lbs.
Weight on leading truck	43,000 lbs.
Weight of engine and tender in working order	298,000 lbs.
Wheel base, driving	15 ft.
Wheel base, total	26 ft. 4 ins.
Wheel base, engine and tender	53 ft. 7½ ins.
RATIOS.	
Tractive weight ÷ tractive effort	4.2
Tractive effort x diam. drivers ÷ heating surface	730
Heating surface ÷ grate area	31.5
Tube heating surface ÷ total heating surface	.904
Tube heating surface ÷ firebox heating surface	13.4
Total heating surface ÷ vol. both cylinders	256.
Grate area ÷ vol. both cylinders	8.17
CYLINDERS.	
Kind	Simple.
Diameter and stroke	21 by 26 ins.
Piston rod, diameter	3½ ins.
Vol. both cylinders, cu. ft.	10.4
VALVES.	
Kind	Rotary.
Greatest travel	3⅝ ins.
Outside lap	⅝ in.
Inside lap	⅛ in.
Lead in full gear	⅛ in.
WHEELS.	
Driving, diameter over tires	63 ins.
Driving, thickness of tires	3½ ins.
Driving journals, diameter and length	9 by 12 ins.
BOILER.	
Style	Wooten.
Working pressure	200 lbs.
Outside diameter of first ring	65 ins.
Firebox, length and width	120 by 102 ins.
Tubes, number and outside diameter	308 2-in.
Tubes, length	15 ft.
Heating surface, tubes	2,405.5 cu. ft.
Heating surface, water bars	78.54 cu. ft.
Heating surface, firebox	179.68 cu. ft.
Heating surface, total	2,663.72 cu. ft.
Grate area	84.85 sq. ft.
Smokestack, height above rail	14 ft. 9 ins.
Center of boiler above rail	111½ ins.
TENDER.	
Tank	Water bottom.
Weight, empty	48,000 lbs.
Water capacity	7,000 gals.
Coal capacity	12 tons.



VALVE—DELAWARE AND HUDSON LOCOMOTIVE WITH YOUNG VALVE AND GEAR.

32-INCH HEAVY DUTY SHAPER.

The 32-in. heavy duty shaper, illustrated herewith, is specially designed for use in railroad shops, is very powerful, and the construction is such that work may be turned out very accurately under the most severe conditions of cutting. The column, which is of unusual width and depth, is braced internally. The horns, which project at both the front and back, furnish an unusually long bearing for the ram. The rocker arm is so constructed that wear may be compensated for. The length of stroke may be changed from the working side either while the machine is in motion or at rest. The rail is strongly gibbed to the column, and a cross traverse screw is provided with a graduated collar reading to .001 in. It is also provided with a variable automatic feed which may be changed while the machine is in operation. The down-feed screw to the head has a graduated collar reading to .001 of an inch.



CINCINNATI 32-INCH HEAVY DUTY SHAPER.

The journal of the main gear has two diameters, the inner end being twice the diameter of the outer end, thus overcoming any tendency to break at the gear; there is also a third or

outer bearing to the cone shaft. The crank block is a steel casting and is set well into the cup of the gear, permitting the rocker arm to travel close to the edge of the gear, thus avoiding the usual overhang.

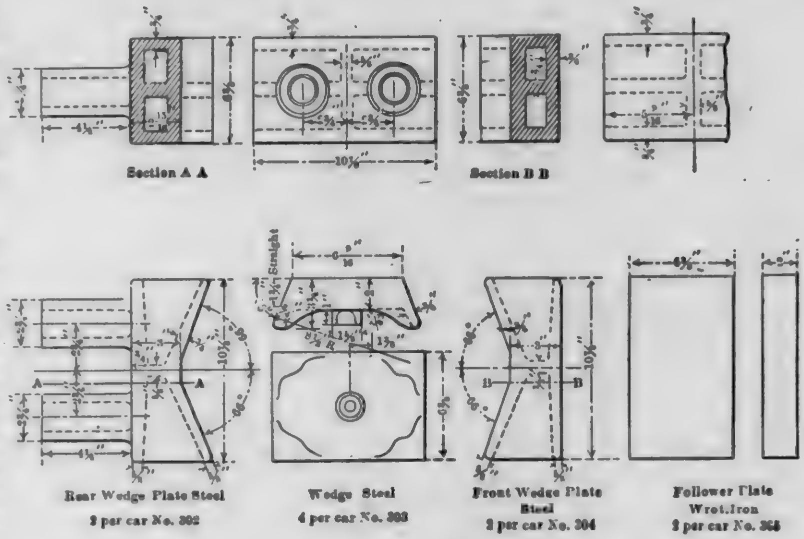
The machine may be used in either single or back-geared form, the ratio of the gearing in one case is 7.2 revolutions of the cone shaft to one stroke of the ram and in the other 30 to 1. The cross feed connecting rod is automatically adjusted to any height of the rail, and is not dependent upon frictional contact. The outer support for the table is of special design and very efficient. The rail is raised and lowered by a telescopic screw, which works on ball bearings. The key-seating of shafting is provided for by an opening through the column under the ram.

The general dimensions of this machine, which is made by the Cincinnati Shaper Company, Cincinnati, Ohio, are as follows:

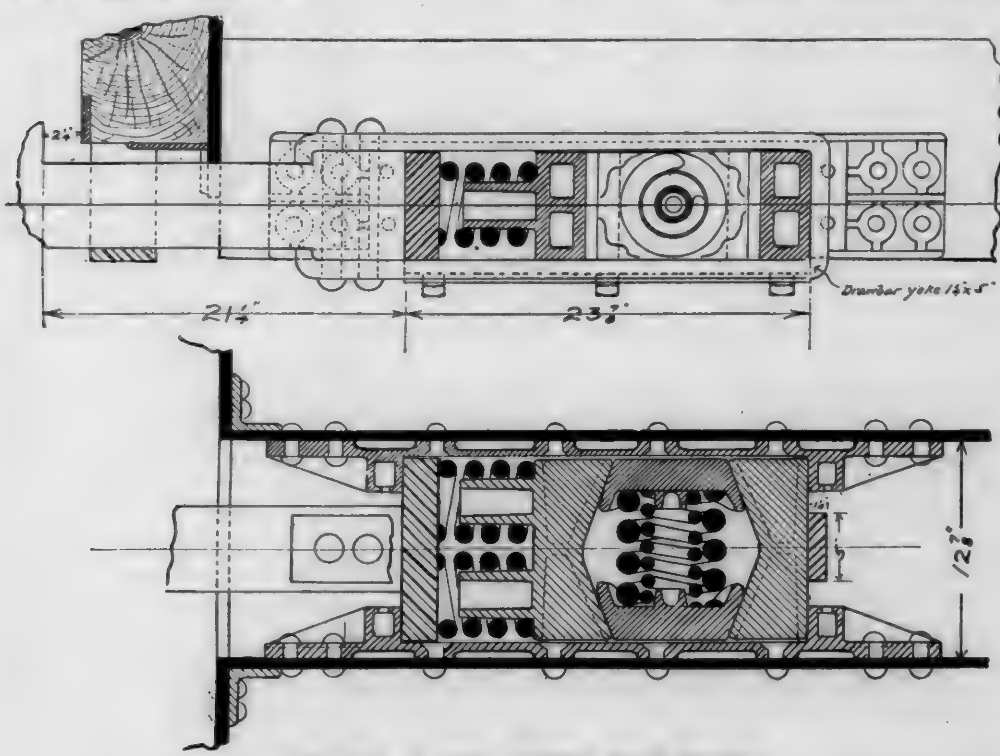
Extreme length of stroke	33 ins.
Greatest distance table to ram	17¼ ins.
Least distance table to ram	2¼ ins.
Vertical travel of table	15 ins.
Horizontal travel of table	32 ins.
Diameter of head	11 ins.
Feed to head	10 ins.
Length of top of table	30 ins.
Width of top of table	16 ins.
Depth of table	20 ins.
Length of ram bearing in column	46 ins.
Width of ram bearing in column	13 ins.
Key-seating capacity, diameter	4 ins.
Vise opens	12 ins.
Number of speeds to ram	8
Cutting strokes per minute, from	6 to 71

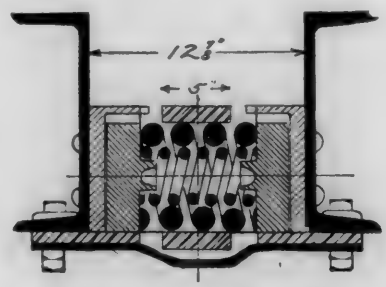
PIPER FRICTION DRAFT RIGGING.

The Piper friction draft rigging, which has been brought to a high point of efficiency through several years of tests and experiments on a large number of cars in actual service, has not until now been placed on the market. The patent granted



DETAILS OF WEDGE PLATES, WEDGES AND FOLLOWER PLATE.

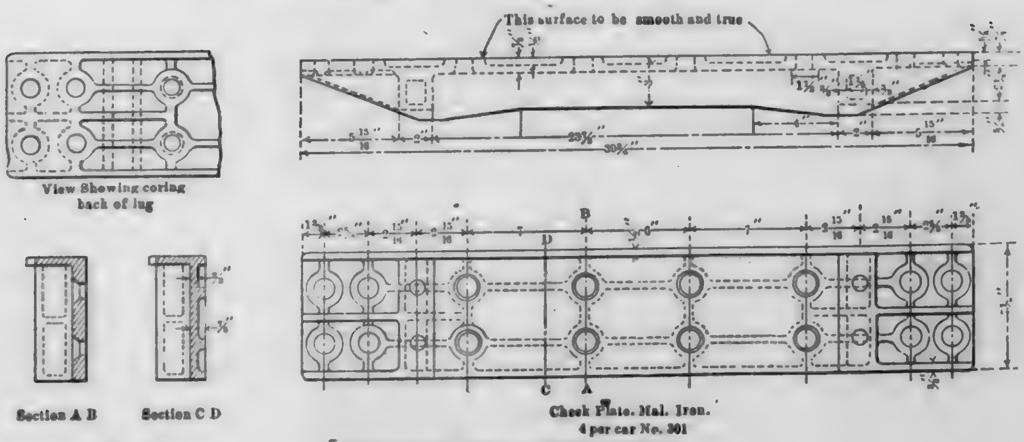




APPLICATION OF PIPER FRICTION DRAFT RIGGING.

to W. M. Piper in 1896 is a pioneer patent and covers broadly any mechanism consisting of blocks having oppositely directed inclines with contracting wedges and springs arranged to resist their movement along the inclines. The arrangement, as illustrated, is one that was developed after exhaustive tests in service and in the laboratory, both as to the amount of preliminary spring resistance necessary, as well as the best angle for the wedges to give an easy movement and a high point of work-absorbing efficiency. The diagram of a test made at Purdue University in 1903, and reproduced here, shows that this particular arrangement is capable, with a preliminary spring movement of 1¼ in. and 25,000 lbs. resistance, of a very high yielding resistance through a total drawbar movement of 2¼ in.

It is generally understood that the first requisite of a good friction draft gear is that it should not be liable to disorder or repair; that the parts be simple and substantial in design, easily

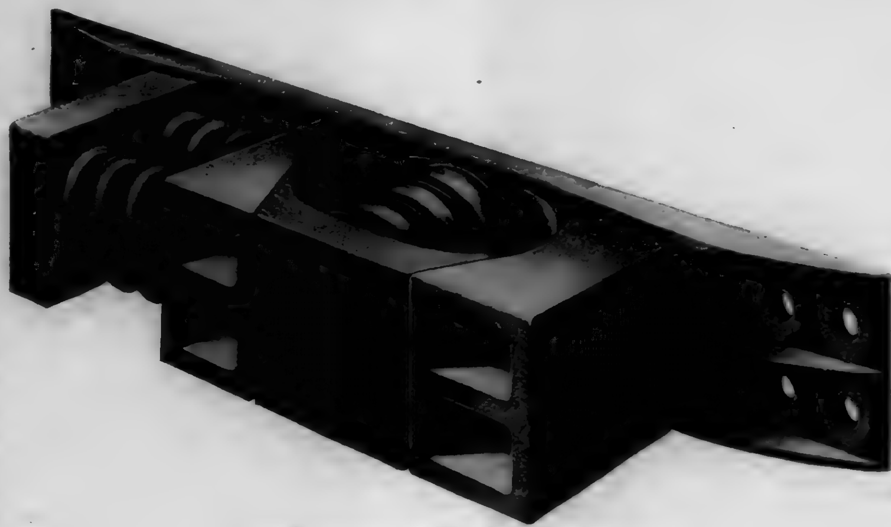


MALLEABLE IRON CHEEK PLATE.

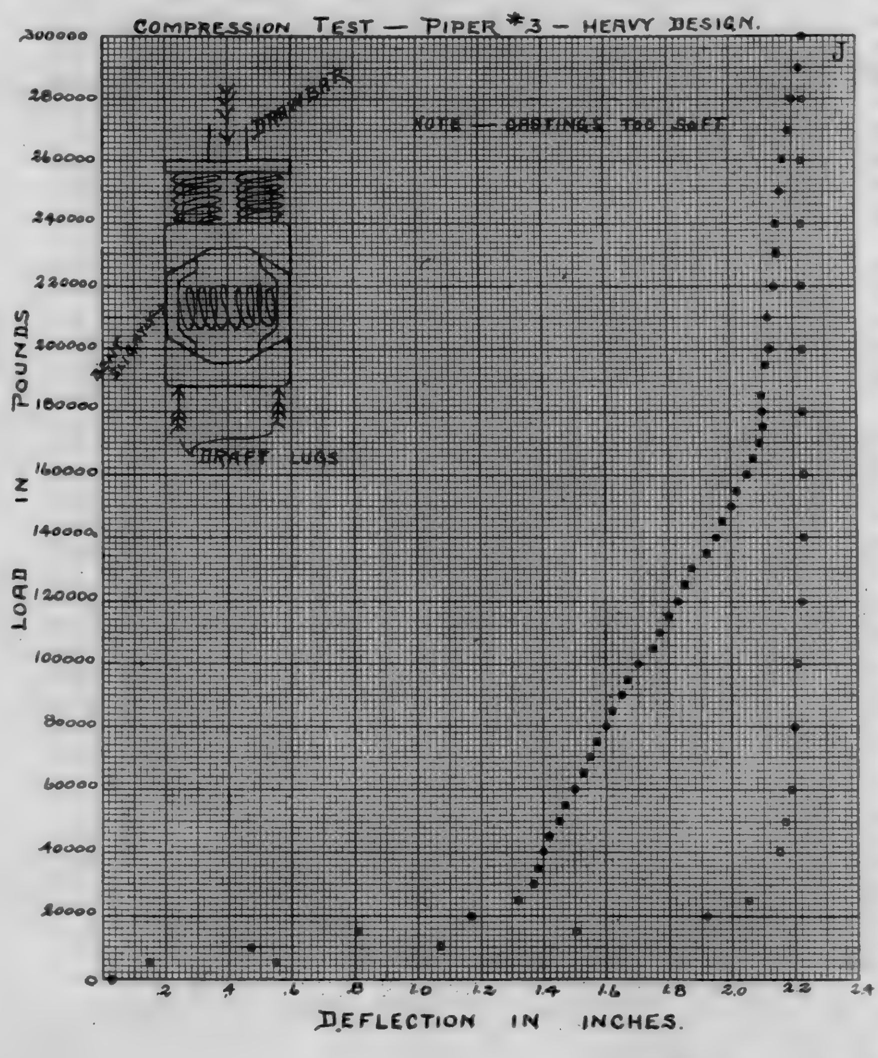
inspected, incapable of being improperly assembled and of such form and construction that it may be cheaply and firmly fastened to the frame of the car, all of which has been thoroughly considered and effectively accomplished in the design of the Piper friction draft rigging.

The road tests of this draft rigging demonstrated the fact that a very considerable amount of easy motion was desirable in the starting of trains and in absorbing the innumerable slight shocks incident to train service. This element is thoroughly taken care of by the front twin-spring arrangement, the friction elements going into operation gradually, with a smooth, easy motion, before the springs are completely compressed, and no shock is possible. An absorbing element, capable of a resistance of 180,000 to 200,000 pounds for each end of a car should give very satisfactory results under the most severe service conditions.

The patents covering the Piper friction draft gear are now owned and controlled by the Butler Drawbar Attachment Company of Cleveland, Ohio, and the gear will be known as the Butler Friction Attachment—Piper Patents. This form of draft gear is capable of being applied in various ways, and any special requirements can be met, the limitations of space and travel being considered, and while being new on the market, it has the superior advantage of having been thoroughly tested in severe service for several years. The high capacity and guaranteed efficiency of the Butler Friction Attachment must certainly recommend it to the operating officials of any railroad.



PIPER FRICTION DRAFT GEAR ASSEMBLED.



BALANCED COMPOUND TEN-WHEEL LOCOMOTIVE.

N., C. & St. L. R. R.

The twenty-seventh thousandth locomotive built at the Baldwin Locomotive Works was a balanced compound, 10-wheel engine for the Nashville, Chattanooga & St. Louis Railway, which is illustrated herewith.

This locomotive has 16 and 27 by 26 inch cylinders and has both main rods connected to the front driver. While this arrangement gives comparatively short main rods, it allows the three driving wheels to be placed very close together, giving a rigid wheel base of but 12 ft., the total wheel base being 26 ft. This will allow the engine to easily take sharp curves, but probably will not tend towards an easy-riding locomotive. In spite of the fact that the driving wheels are set far enough back to connect the rods to the front wheel, the design is such that 73 per cent. of the total weight comes on the drivers. Compared with engines using a trailing wheel, this is a large percentage.

The eccentrics are, of course, on the second axle, and the rocker arm is placed between the two front drivers and connects with the valve through a very long valve rod, which passes through the front driving box spring cap and has a bearing in the guide yoke.

The single bar front frame, necessary with this type of cylinder, is made particularly heavy in section and strong in connection. The connection to the main frame is secured by 8 1¼ in. bolts in addition to two large keys, and at the cylinders, where the frame has a section of 3½ by 8 ins., it is fitted into a recess in the cylinder casting and secured by lugs, on either end, with keys, also by two 1¼ in. bolts, which pass through the frame and lugs on the castings as well as six straps across the bottom. This detail appears, in this case, to have received the thought and care that it really deserves.

A narrow firebox, having a grate area of but 34.8 sq. ft., and a wagon-top boiler, with a diameter of 64 ins. at the front end, is used. The heating surface is, however, larger than might be expected, as but 17-ft. flues are used, it being 2,735 sq. ft. total; this gives 78.5 sq. ft. of heating surface per sq. ft. of grate area, a figure which was not unusual when narrow firebox locomotives were general, but one which is considerably larger than is found in the later engines. The flues, which are 2¼ ins. in diam-

10-WHEEL (4-6-0 TYPE) BALANCED COMPOUND LOCOMOTIVE—NASHVILLE, CHATTANOOGA AND ST. LOUIS RAILROAD.

eter, are set at 3-in. centers. This permits 256 of them to be placed in the boiler shell. A steam pressure of 210 lbs. is used.

Reference to the table of proportions of this locomotive will show that, as compared with a simple engine of the same power, it would be considered that the cylinders were somewhat large for the boiler capacity, but, inasmuch, as the balanced compound feature is used and the cylinder power is divided more evenly, this will probably not prove to be the case the B D factor (tractive effort × dia. drivers ÷ total heating surface*) while somewhat above that employed in recent balanced compounds, still is not excessively large, and would indicate that the engine would do its best work at a medium sped.

The general dimensions, weights and ratios follow:

4—6—0 TYPE VAUCLAIN BALANCED COMPOUND PASSENGER LOCOMOTIVE, NASHVILLE, CHATTANOOGA AND ST. LOUIS RY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal.
Tractive power	29,050 lbs.
Weight in working order	181,380 lbs.
Weight on drivers	133,920 lbs.
Weight on leading truck	47,460 lbs.
Weight of engine and tender in working order	280,000 lbs.
Wheel base, driving	12 ft.
Wheel base, total	26 ft.
Wheel base, engine and tender	55 ft. 2 ins.

RATIOS.

Tractive weight ÷ tractive effort	4.6
Tractive effort x diam. drivers ÷ heating surface	702
Heating surface ÷ grate area	78.5
Total weight ÷ tractive effort	6.24
Tube H. S. ÷ total H. S.	.932
Tube H. S. ÷ firebox H. S.	13.8
Total H. S. ÷ vol. both cylinders	308
Grate area ÷ vol. both cylinders	3.92

CYLINDERS.

Kind	Balanced compound.
Diameter and stroke	16 and 27 by 26 ins.
Vol. both cylinders, cu. ft.	8.9

VALVES.

Kind	Piston.

WHEELS.

Driving, diameter over tires	66 ins.
Driving, thickness of tires	3 ins.
Driving journals, main, diameter and length	10 by 10½ ins.
Driving journal, others	9 by 12 ins.
Engine truck wheels, diameter	30 ins.
Engine truck, Journals	5½ by 12 ins.

BOILER.

Style	Wagon top.
Working pressure	210 lbs.
Outside diameter of first ring	64 ins.
Firebox, length and width	120 by 41¼ ins.
Firebox plates, thickness	⅜, 7-16 and ½ in.
Firebox, water space	4 and 3 ins.
Tubes, number and outside diameter	256 2¼-in.
Tubes, length	17 ft.
Heating surface, tubes	2,550 sq. ft.
Heating surface, firebox	185 sq. ft.
Heating surface, total	2,735 sq. ft.
Grate area	34.8 sq. ft.
Centre of boiler above rail	106 ins.

TENDER.

Wheels, diameter	33 ins.
Journals, diameter and length	5 by 9 ins.
Water capacity	5,000 gals.

*American Engineer, Feb., 1903, p. 58.

EXPERIMENTAL LOCOMOTIVES, PENNSYLVANIA RAILROAD.

The Pennsylvania Railroad holds a special position among American Railroads in respect to its readiness to undertake the careful testing of any new design or device which seems to have elements pertaining toward improved locomotive or car performances. The organization of the company is such that testing of this nature can be carried on in a careful and thorough manner and the results obtained can be accepted as accurate and reliable.

The latest evidence of this position is found in the purchase of eight new locomotives, two each of four different designs, each including some comparatively new feature or arrangement. In selecting the types, those chosen were ones designed and built by the locomotive builders, which are in regular service on other railroads and which, to a certain extent, have been tried out and developed. In fact, all untried features were avoided as far as possible. To this group should also be added the DeGlehn compound locomotive bought in 1904, and partially tested on the Pennsylvania testing plant at the St. Louis World's Fair. A complete illustrated description of that locomotive was given in the AMERICAN ENGINEER AND RAILROAD JOURNAL in June, 1904.

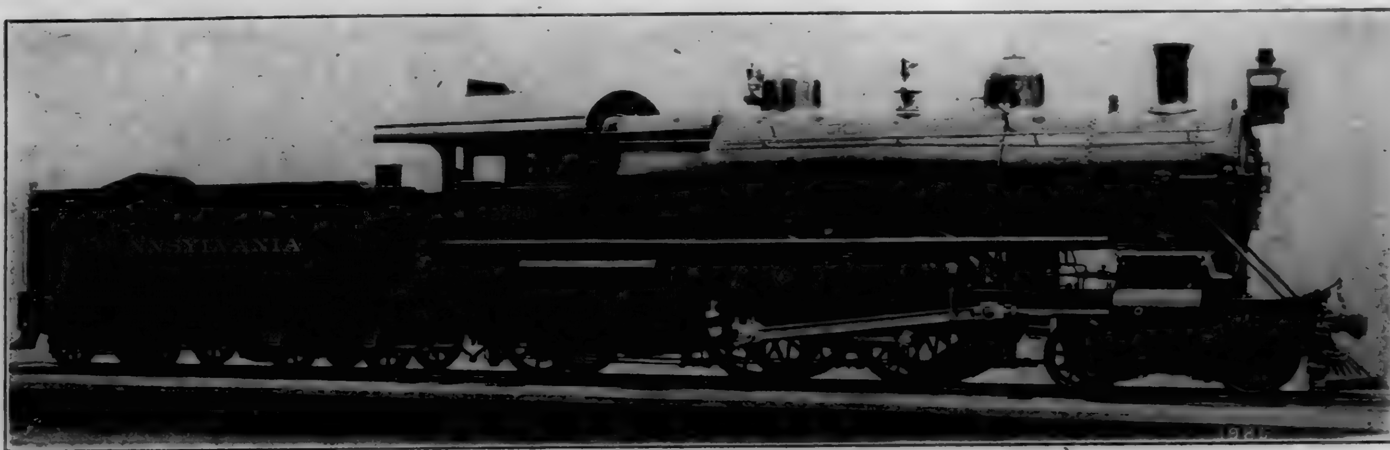
Of the four types of American design, three are passenger locomotives; two of which are balanced compound Atlantic type and one simple Prairie type with Walschaert valve gear, and the other is a large simple consolidation freight engine. These locomotives are now in regular service, one of each type on the lines east and one on the lines west of Pittsburgh, and complete reports of their performances, as compared with the standard locomotives of the company, are being taken.

It will be remembered that this company made a similar service test of different types of compound locomotives in 1896, all of the two-cylinder cross compound design. The group purchased at that time consisted of four mogul engines, the same in all respects except as to cylinders, which were also all of the same size, being 20 and 29 by 28 ins. There was one each using the Golsdorf, Von Borries, Pittsburg and Richmond designs for compounding. At that time the primary object of using steam in compound cylinders was for the purpose of saving fuel, and all of these locomotives proved to be a success in that respect, as compared with the simple engines of the same power, but for reasons connected with operation and cost of maintenance none of those types have proved to be a practical success under American conditions.

At the present time a successful system of compounding is sought with a different and much more vital point in view, having as its primary object the increasing of the hauling power and the sustained speed of the passenger locomotives, together with the but slightly secondary object of designing a machine which will operate at high speeds with less damage to itself and the track than is caused by the present designs

of high speed locomotives. The three different designs for these purposes, included in this group have, in one case from long foreign and in two cases from comparatively brief American experience, shown themselves to be very successful and the indications are that these types will not follow their predecessors into quick disuse.

The other passenger locomotive is of a type which, while new on the Pennsylvania Railroad, has been in long service on other American roads, the most notable previous example being the class J-41 engine of the Lake Shore & Michigan Southern Railway (AMERICAN ENGINEER, 1904, page 413), which has, up to this time, held the record as being the heaviest passenger locomotive ever built. The test on this engine



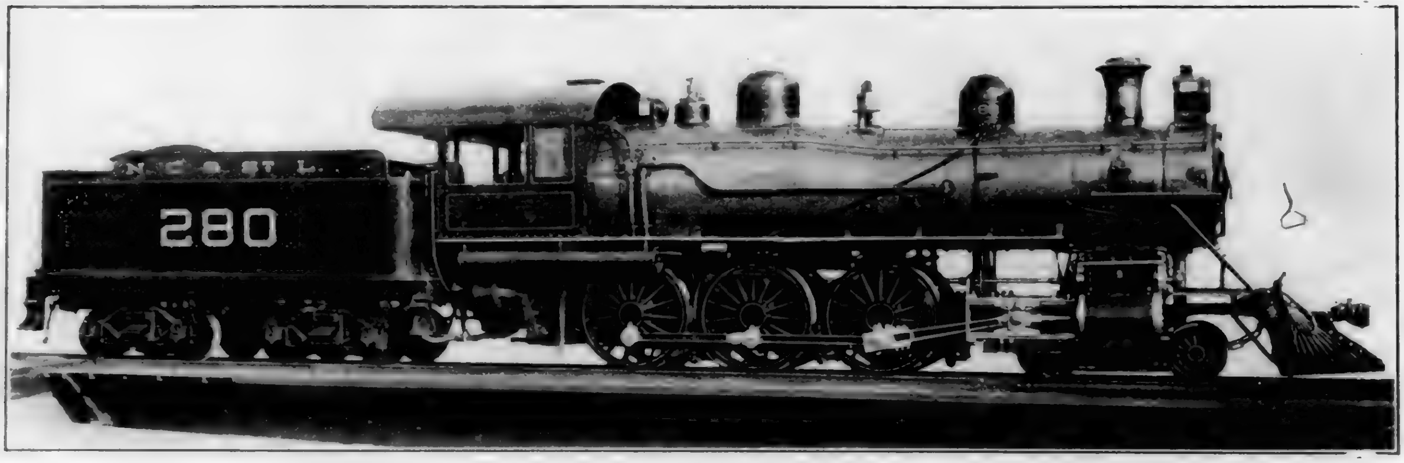
ATLANTIC (4-4-2) TYPE VAUCLAIN BALANCED COMPOUND LOCOMOTIVE—PENNSYLVANIA RAILROAD.

ATLANTIC (4-4-2) TYPE COLE BALANCED COMPOUND LOCOMOTIVE—PENNSYLVANIA RAILROAD.

PRAIRIE (2-6-2) TYPE PASSENGER LOCOMOTIVE, WITH WALSCHAERT VALVE GEAR—PENNSYLVANIA RAILROAD.

CONSOLIDATION (2-8-0 TYPE) FREIGHT LOCOMOTIVE—PENNSYLVANIA RAILROAD.

PENNSYLVANIA EXPERIMENTAL LOCOMOTIVES.



10-WHEEL (4-6-0 TYPE) BALANCED COMPOUND LOCOMOTIVE—NASHVILLE, CHATTANOOGA AND ST. LOUIS RAILROAD.

eter, are set at 3-in. centers. This permits 256 of them to be placed in the boiler shell. A steam pressure of 210 lbs. is used.

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The general dimensions, weights and ratios follow:

4—6—0 TYPE VAUCLAIN BALANCED COMPOUND PASSENGER LOCOMOTIVE, NASHVILLE, CHATTANOOGA AND ST. LOUIS RY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal.
Tractive power	29,050 lbs.
Weight in working order	181,380 lbs.
Weight on drivers	133,920 lbs.
Weight on leading truck	47,460 lbs.
Weight of engine and tender in working order	280,000 lbs.
Wheel base, driving	12 ft.
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Wheel base, engine and tender	55 ft. 2 ins.

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RATIOS.

Tractive weight ÷ tractive effort	4.6
Tractive effort x diam. drivers ÷ heating surface	702
Heating surface ÷ grate area	78.5
Total weight ÷ tractive effort	6.24
Tube H. S. ÷ total H. S.	.932
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CYLINDERS.

Kind	Balanced compound.
Diameter and stroke	16 and 27 by 26 ins.
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VALVES.

Kind	Piston.

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Driving, diameter over tires	66 ins.
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Driving journals, main, diameter and length	10 by 10¼ ins.
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Engine truck wheels, diameter	30 ins.
Engine truck, journals	5½ by 12 ins.

BOILER.

Style	Wagon top.
Working pressure	210 lbs.
Outside diameter of first ring	64 ins.
Firebox, length and width	120 by 41⅞ ins.
Firebox plates, thickness	⅝, 7-16 and ½ in.
Firebox, water space	4 and 3 ins.
Tubes, number and outside diameter	256 2¼-in.
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Heating surface, tubes	2,550 sq. ft.
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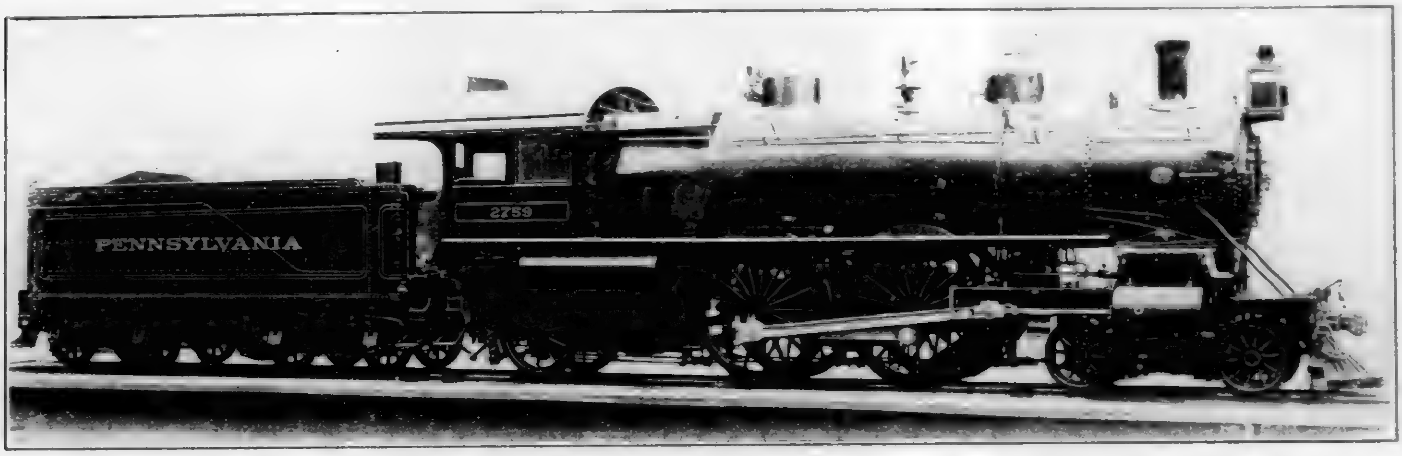
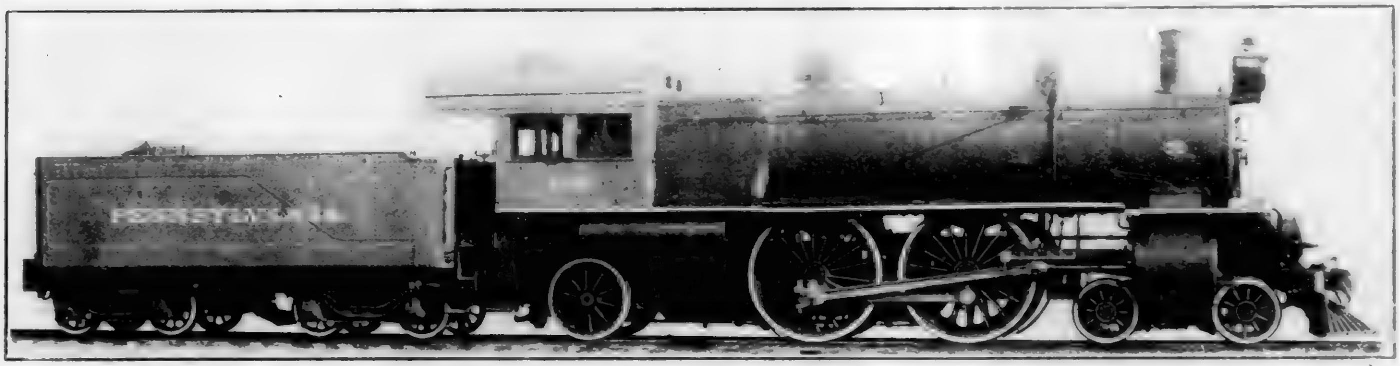
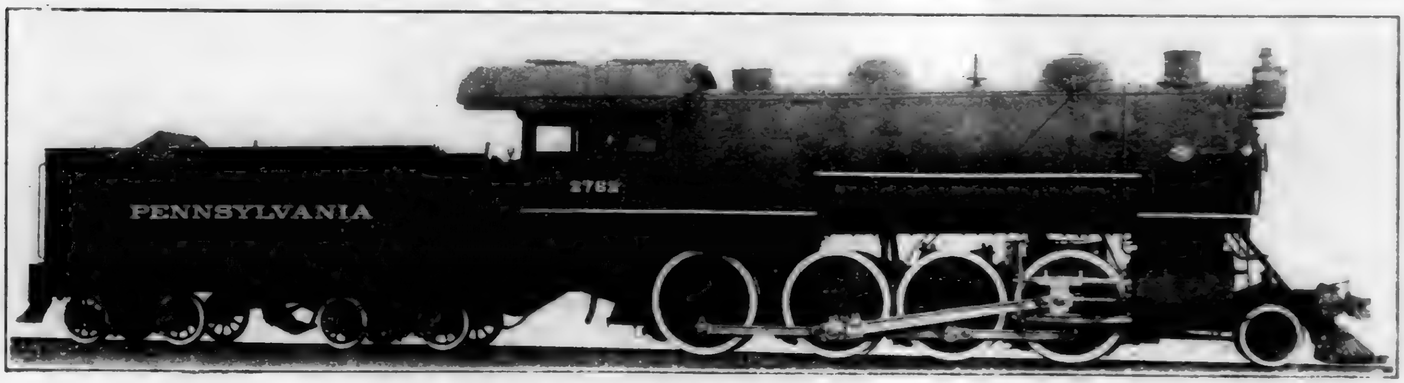


ATLANTIC (4-4-2) TYPE VAUCLAIN BALANCED COMPOUND LOCOMOTIVE—PENNSYLVANIA RAILROAD.



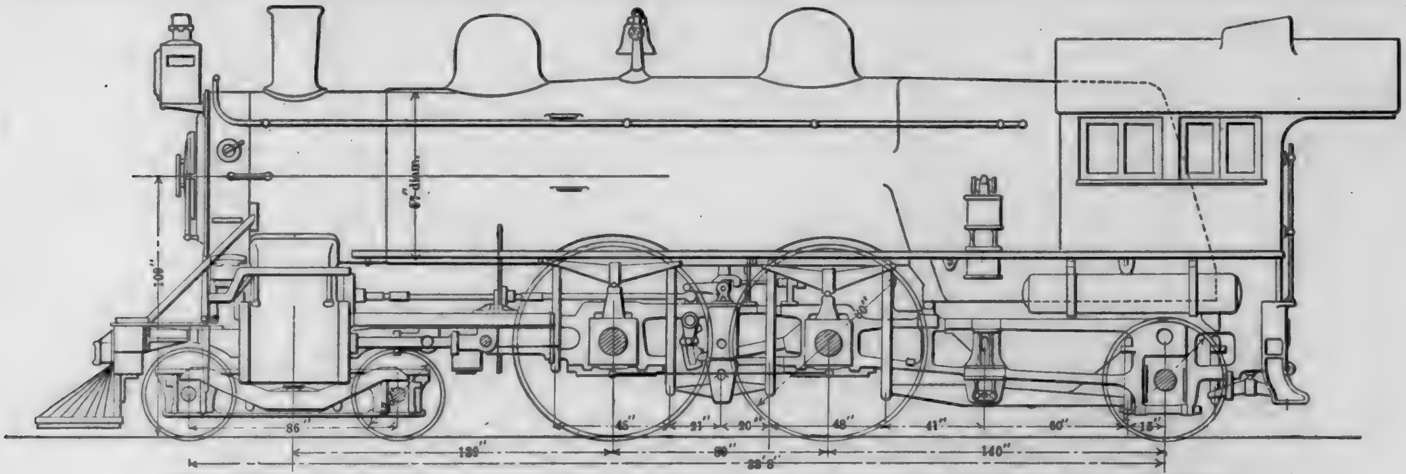
ATLANTIC (4-4-2) TYPE COLE BALANCED COMPOUND LOCOMOTIVE—PENNSYLVANIA RAILROAD.

PRAIRIE (2-6-2) TYPE PASSENGER LOCOMOTIVE, WITH WALSCHAERT VALVE GEAR—PENNSYLVANIA RAILROAD.

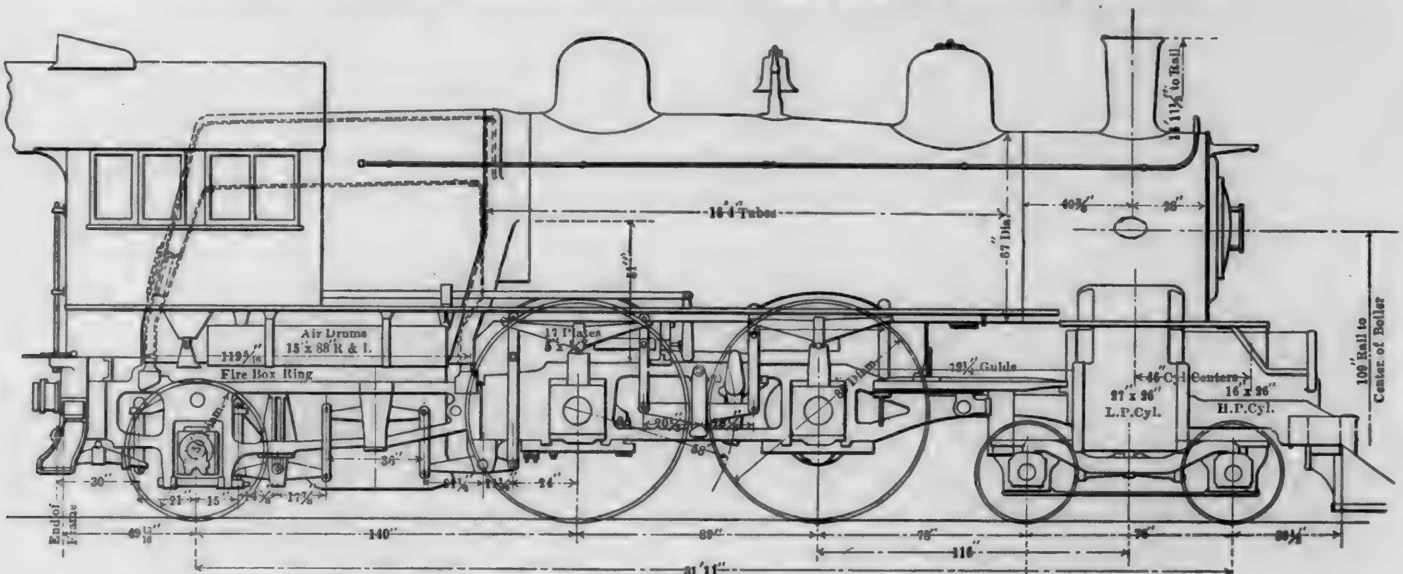


CONSOLIDATION (2-8-0 TYPE) FREIGHT LOCOMOTIVE—PENNSYLVANIA RAILROAD.

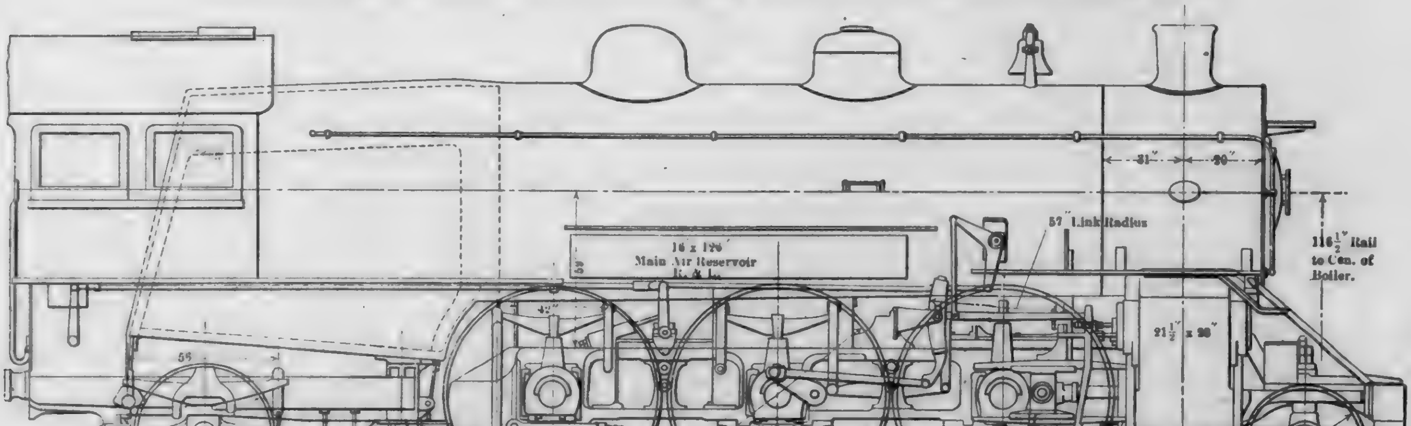
PENNSYLVANIA EXPERIMENTAL LOCOMOTIVES.



EXPERIMENTAL LOCOMOTIVE, PENNSYLVANIA RAILROAD, VAUCLAIN BALANCED COMPOUND, ATLANTIC TYPE.



EXPERIMENTAL LOCOMOTIVE, PENNSYLVANIA RAILROAD, COLE BALANCED COMPOUND, ATLANTIC TYPE.



EXPERIMENTAL LOCOMOTIVE, PENNSYLVANIA RAILROAD, PRAIRIE TYPE, WITH WALSCHAERT VALVE GEAR.

will be two-fold—the use of the two wheel leading truck on a line having many curves and the performance of the Walschaert valve gear on a high speed passenger locomotive.

The fifth locomotive of the group, a large consolidation freight engine, is simply a very powerful engine for heavy service, built from a straightforward strictly American design.

Referring to the particular locomotives comprising this group, the table of dimensions, together with the general views and outline diagrams herewith, will give a clear idea of each.

The DeGlehn compound engine, as above mentioned, has been thoroughly illustrated and described in these columns, and while being included in this group for experimental purposes is not illustrated herewith.

The Prairie type passenger locomotive is almost identical with the Lake Shore & Michigan Southern Railway engine mentioned above, it being 1,500 lbs. heavier in total weight and having 800 lbs. more weight on drivers. The cylinders are the same in both cases, being 21½ by 28 ins. The former locomotive has slightly more heating surface, due to a larger number of tubes in the boiler. The diameter of the drivers

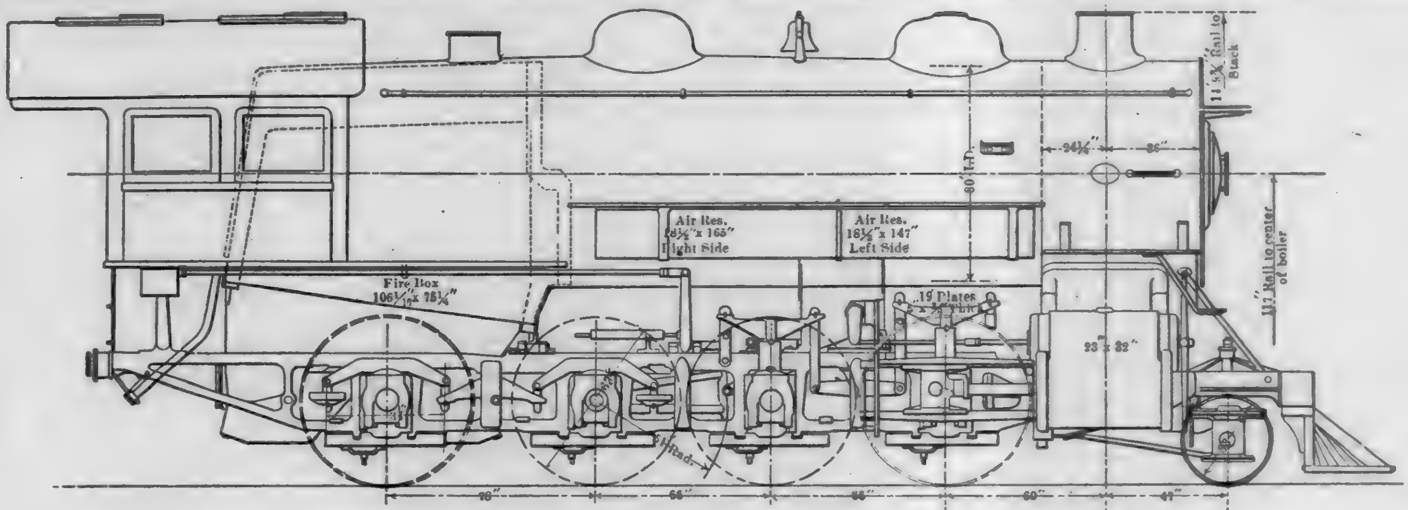
in the latter engine being one inch larger gives it a slightly less theoretical tractive power, but in all other respects, excepting the valve gear, the two locomotives are practically identical.

The Walschaert valve gear here used has been described and illustrated in principle and detail in these columns many times during the past two years. The reports from examples already in use seem to be uniformly favorable, and the present indications are that the gear will come into fairly general use in this country.

The two balanced compound Atlantic type engines will be seen, by referring to the tables of dimensions, to be practically identical in all respects except cylinder arrangements. They both employ 16 and 27 by 26 in. cylinders, weigh in the neighborhood of 200,000 lbs. total and carry 205 lbs. of steam. The boiler of the Baldwin balanced compound has slightly longer flues, there being 261—2¼ ins. in diameter and 17 ft. 8 ins. long, while the Cole compound of the American Locomotive Company has 315—2-in. flues 16 ft. 4 ins. long, the heating surface in both cases being almost the same.

For details of the cylinder arrangement and connection of the Cole balanced compound reference can be made to the illustrated description of a similar locomotive for the New York Central & Hudson River Railroad (AMERICAN ENGINEER AND RAILROAD JOURNAL, June, 1904, page 241), and for the Baldwin balanced compound to a description of a similar locomotive for the Chicago, Burlington & Quincy Railroad in June, 1904, page 211, and for the cylinder arrangement to June, 1903, page 210.

The consolidation locomotive is almost an exact duplicate of a locomotive built by the American Locomotive Company for the New York Central & Hudson River Railroad, and illustrated in the AMERICAN ENGINEER AND RAILROAD JOURNAL, January, 1904, page, 16. The Pennsylvania engine weighs 1,000 lbs. more in total and 2,000 lbs. more on drivers. The tractive power is the same in both cases.



EXPERIMENTAL LOCOMOTIVE, PENNSYLVANIA RAILROAD, SIMPLE CONSOLIDATION.

Dimensions, Weights and Ratios of Experimental Locomotives, P. R. R.

Type	2-6-2	4-4-2	4-4-2	4-4-2	2-8-0
Road Numbers	2761	2759	2760	2512	2762
Builder	American	Baldwin	American	Soc. Als.	American
Steam distribution	Simple	Bal. Comp.	Cole Comp.	De Glehn	Simple
Cylinder diameter, ins	21½	16 and 27	16 and 27	14.19 & 23.625	23
Stroke, ins	28	26	26	25.19	32
Total weight, lbs	234,500	195,900	200,500	164,000	220,000
Weight on drivers, lbs	166,800	120,500	117,200	87,850	198,000
Diameter of drivers, lbs	80	80	80	80.19	[illegible]
Valve	Piston	Piston	Piston	P & S	P
Valve gear (Walschaert or Stephenson)	W	S	S	W	S
Diameter of boiler	74½ ins.	67 ins.	67 ins.	58⅛ ins.	81⅝ ins.
Length of flues	19 ft. 6 ins.	17 ft. 8 ins.	16 ft. 4 ins.	14 ft. 5¾ ins.	15 ft. 6 ins.
Diameter of flues	2¼ ins.	2¼ ins.	2 ins.	2⅝ ins. †	2 ins.
Number of flues	322	261	315	139	446
Length of firebox	108 1-8 ins.	111 in.	111 ins.	120 ins.	106 ins.
Width of firebox	73¼ ins.	72 ins.	72 ins.	39⅝ ins.	75¼ ins.
Grate area, sq. ft	55	55.5	55.5	33.9	55.4
Heating surface—flues, sq. ft	3677.9	2698	2,680	2435.7	3596.5
Heating surface—firebox, sq. ft	202.7	166	181.4	181.1	177.1
Heating surface—total, sq. ft	3881.6	2864	2861.6	2616.8	3773.6
Height, centre boiler	9 ft. 8½ ins.	9 ft. 1 in.	9 ft. 1 in.	8 ft. 10 5-16 in.	9 ft. 9 ins.
Steam pressure	200	205	205	227½	200
Tender—water capacity	7000 gals.	5500 gals.	5500 gals.	5500 gals.	7000 gals.
Tender—coal capacity	10 tons.	12½ tons	10 tons.	11 tons.	13 tons
Tender—weight loaded	139,300 lbs.	132,100 lbs.	125,300 lbs.	132,500 lbs.	140,500 lbs.
Vol. both cyl., cu. ft.*	11.76	8.9	8.9	7.15	15.4
Tractive effort	27,520	23,300	23,300	19,555	45,700
Ratio—Weight on drivers ÷ tractive effort	6.1	5.17	5.	4.5	4.33
" Total weight ÷ weight on drivers	1.41	1.63	1.71	1.87	1.11
" Total H. S. ÷ grate area	70.6	51.7	51.6	77.1	67.4
" Tube H. S. ÷ total H. S.	.946	.94	.937	.932	.954
" Tube H. S. ÷ firebox H. S.	18.12	16.3	14.8	13.42	20.25
" Total H. S. ÷ Vol. both cyl.	330	322	322	366	245
" Grate area ÷ Vol. both cyl.	4.68	6.23	6.23	4.74	3.6
" Tractive effort x diameter drivers ÷ total heating surface.	568	650	650	600	765

*Volume of cylinders of equivalent simple engine used for compounds.
† Servé tubes.

A RECORD IN TIRE TURNING.

Fifteen pairs of driving wheels, ranging from 50 to 72 ins. in diameter, turned in 13 hours 24 minutes, or requiring an average of 53 3-5 minutes to put a pair of wheels in the lathe, turn and take them out, is the record made at the West Albany shops of the New York Central. The chips removed from these wheels weighed 2,860 lbs. The results of the test are shown on the accompanying table. The tires in all cases were of Midvale steel. This record was made on December 18th and 19th, five pairs of driving wheels being turned out in 258 minutes on the 18th and ten pairs in 546 minutes on the 19th.

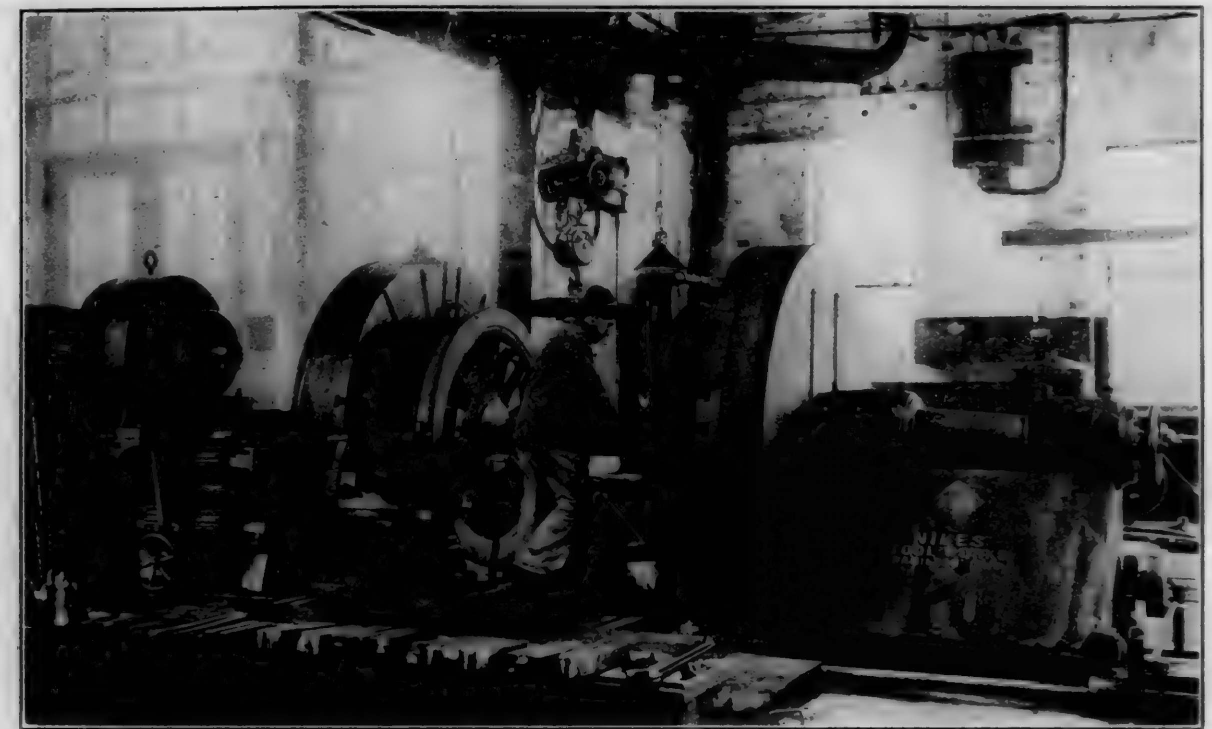
The machine upon which this record was made is the most recent design of 90-in. Niles driving wheel lathe equipped with the "sure grip" drivers, and weighs about 120,000 lbs. The face plates are provided with openings for the crank pins, so that the wheels may by chucked close to the face plates; the movable head is transversed by a 5-h. p. Westinghouse type S motor. The distance between the face plates may be varied from 6 ft. 8 ins. to 9 ft. The swing over the bed is 92 ins.; the diameter of the face plate is 90 ins., and the machine will take wheels from 50 to 84 ins. in diameter without changing the position of the carriages. It is driven by a 40 h.-p. Westinghouse type S motor, having a speed variation of from 1 to 2, which, when combined with changes by gearing, provides cutting speeds of from 10 to 25 ft. per minute on all diameters from 48 to 84 ins. During the test as much as 58 to 60 h.p. was required at times to drive the machine. The cutting speed varied from 8 ft. 6 ins. to 14 feet per minute, most of the work being done at 12 ft. 9 ins. per minute.

The tools used are quite similar to those used at the Angus shops, and illustrated on page 56 of this issue. Where no hard spots were encountered the wheel was turned complete in from 21 to 23 revolutions, divided about as follows: Eight or nine for the roughing cut on the tread, three across the top of the flange, and one revolution each to rough down the front and back of the flange; this was all done with one setting of the tool. The scraper was then applied to the tread of the wheel, smoothing it up in two revolutions; two revolutions were required for cutting the outer bevel and chamfering the outside corners of the tread, and two on each side for finish-

TEST OF NILES 90-INCH DRIVING WHEEL LATHE, MIDVALE TIRES—WEST ALBANY SHOPS, NEW YORK CENTRAL LINES.

Date.	Diam. of Wheel Centre. Ins.	Kind of Tool.	Size of Tool, Ins.	Speed Feet per Minute.	Feed per Revolution Ins.	Depth of Cut, Ins.	Distance Traveled, Ins.	Condition of Tool.	TIME USED—MINUTES. Putting Wheel in & Fastening.	Cutting.	Taking out Wheel.	Total.
12—18—'05	50	Rex—A	3x1½	12 ft. 9 in.	15-32	5-16	5-¾	Good.	7	39	3	49
		Mushet	3x1½	12 ft. 9 in.	15-32	1-4	3	Point burnt off.				
		Rex—A	3x1½	12 ft. 9 in.	15-32	1-4	2-¾	Good.				
12—18—'05	50	Rex—A	3x1½	12 ft. 9 in.	15-32	7-16	5-¾	Good.	7	40	3	50
		Mushet	3x1½	12 ft. 9 in.	15-32	7-16	5-¾	Good.				
12—18—'05	50	Rex—A	3x1½	12 ft. 9 in.	15-32	5-16	5-¾	Good.	7	41	3	51
		Rex—A	3x1½	12 ft. 9 in.	15-32	5-16	5-¾	Good.				
12—18—'05	57	Rex—A	3x1½	12 ft. 9 in.	15-32	1-2	5-¾	Good.	8	44	4	56
		Mushet	3x1½	12 ft. 9 in.	15-32	1-2	1-½	Point burnt off.				
		Rex—A	3x1½	12 ft. 9 in.	15-32	1-2	4-¼	Good.				
12—18—'05	57	Rex—A	3x1½	12 ft. 9 in.	15-32	7-16	5-¾	Good.	7	42	3	52
		Rex—A	3x1½	12 ft. 9 in.	15-32	7-16	5-¾	Good.				
12—19—'05	57	Rex—A	3x1½	12 ft. 9 in.	15-32	5-16	5-¾	Good.	6	45	2	53
		Midvale	3x2	12 ft. 9 in.	15-32	7-16	15-32	Point burnt off.				
		Rex—A	3x1½	12 ft. 9 in.	15-32	7-16	5-9-32	Good.				
12—19—'05	57	Rex—A	3x1½	12 ft. 4 in.	15-32	7-16	5-¾	Good.	7	46	2	55
		Rex—A	3x1½	12 ft. 4 in.	15-32	7-16	2	Point burnt off.				
		Rex—A	3x1½	12 ft. 4 in.	15-32	7-16	3-¾	Good.				
12—19—'05	57	Rex—A	3x1½	12 ft. 6 in.	15-32	9-16	5-¾	Good.	8	44	2	54
		Rex—A	3x1½	12 ft. 6 in.	15-32	9-16	5-¾	Good.				
12—19—'05	57	Rex—A	3x1½	11 ft. 8 in.	15-32	1-2	5-¾	Good.	7	43	2	52
		Rex—A	3x1½	11 ft. 8 in.	15-32	1-2	5-¾	Good.				
12—19—'05	57	Rex—A	3x1½	12 ft. 3 in.	15-32	9-16	5-¾	Good.	6	42	2	50
		Rex—A	3x1½	12 ft. 3 in.	15-32	7-16	3-¾	Point broken off.				
		Rex—A	3x1½	12 ft. 3 in.	15-32	7-16	2	Good.				
12—19—'05	57	Rex—A	3x1½	10 ft 8 in.	15-32	1-2	5-¾	Good.	6	50	2	58
		Rex—A	3x1½	10 ft. 8 in	15-32	1-2	5-¾	Good.				
12—19—'05	57	Rex—A	3x1½	11 ft. 9 in.	15-32	7-16	5-¾	Good.	6	52	2	60
		Rex—A	3x1½	11 ft. 9 in.	15-32	7-16	2	Point broken off.				
		Rex—A	3x1½	8 ft. 6 in.	15-32	3-8	1	Point broken off.				
		Rex—A	3x1½	8 ft. 6 in.	15-32	5-16	2-¾	Good.				
12—19—'05	57	Rex—A	3x1½	11 ft.	15-32	1-2	5-¾	Good.	7	47	2	56
		Rex—A	3x1½	11 ft	15-32	1-2	5-¾	Good.				
12—19—'05	72	Rex—A	3x1½	14 ft	13-32	3-8	5-¾	Good.	8	46	2	56
		Rex—A	3x1½	14 ft	13-32	3-8	5-¾	Good.				
12—19—'05	72	Mushet	3x1½	14 ft.	13-32	5-16	5-¾	Good.	7	43	2	52
		Mushet	3x1½	14 ft	13-32	7-16	5-¾	Good.				
								TOTAL	104	664	36	804

Weight of chips from 15 pair of wheels 2860 lbs. 15 pairs, 13 hours, 24 minutes. Average 53 3-5 minutes.



NILES 90-INCH DRIVING WHEEL LATHE—WEST ALBANY SHOPS.

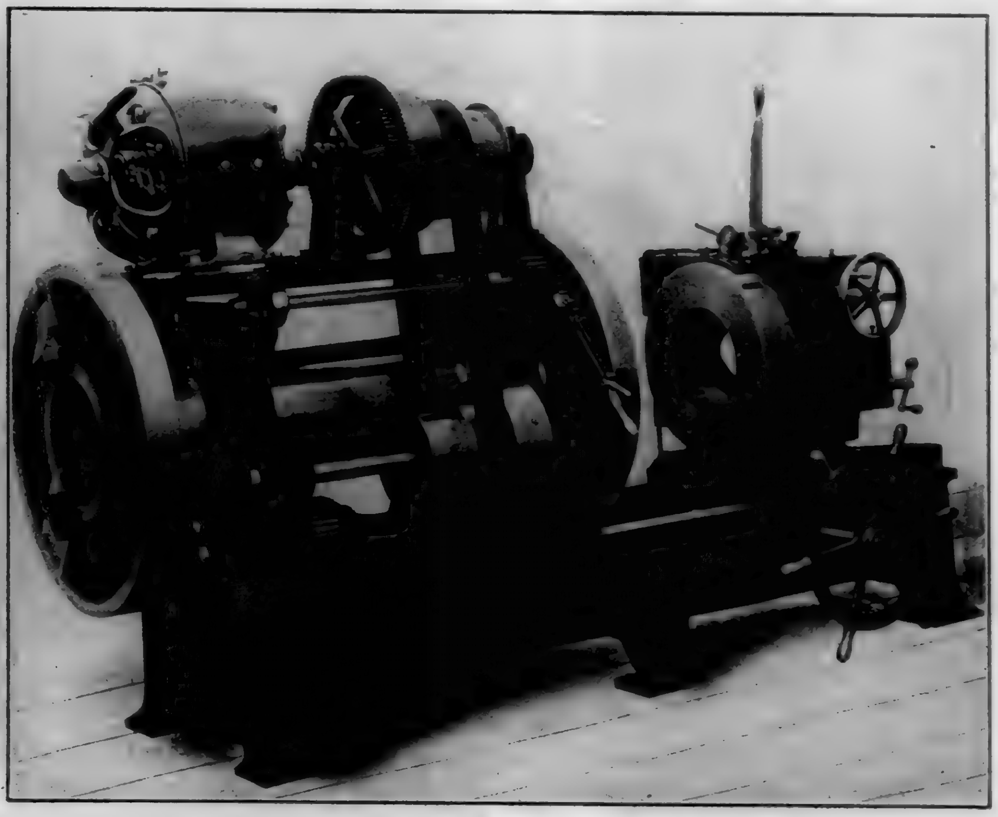
ing the flange. These finishing cuts required four tool settings. We are indebted for information to Mr. R. T. Shea, general inspector of tools and machinery for the New York Central Lines.

IMPROVED PIPE THREADING AND CUTTING OFF MACHINE.

The Duplex No. 12 improved threading and cutting off machine, made by the Bignall & Keeler Manufacturing Company, Edwardsville, Ill., is equipped with adjustable expanding dies and is designed to thread and cut off standard pipe from 4 to 12 ins. in diameter. Each machine is furnished with nine sets of dies, one for each size of pipe, each set consisting of eight chasers. The chucks have each three independent jaws operated by powerful screws; tempered steel grips, which may readily be removed and resharpened, are dovetailed into the ends of the jaws. The jaws are graduated on the face so that they may easily be set for any size of pipe. Special flange grippers, which are very convenient when making up flanges or flanged fittings, are placed on the outside of the jaws of the rear chuck.

The die head is of a very substantial design and is equipped with the Peerless adjusting mechanism, which is very simple and accurate. Duplicate threads of exact gauge can always be obtained and the gauge may be varied by .001 in. All of the adjustments are made by hand and the dies may be inserted in the head without removing any of the parts. The cutting

SHOWING ROUGHING CUTS TAKEN ON TREAD OF TIRE AT WEST ALBANY SHOPS.



IMPROVED PIPE THREADING AND CUTTING OFF MACHINE.

A RECORD IN TIRE TURNING.

Fifteen pairs of driving wheels, ranging from 50 to 72 ins. in diameter, turned in 13 hours 24 minutes, or requiring an average of 53 3-5 minutes to put a pair of wheels in the lathe, turn and take them out, is the record made at the West Albany Shops of the New York Central. The chips removed from these wheels weighed 2,860 lbs. The results of the test are shown on the accompanying table. The tires in all cases were of Midvale steel. This record was made on December 18th and 19th, five pairs of driving wheels being turned out in 258 minutes on the 18th and ten pairs in 546 minutes on the 19th.

The machine upon which this record was made is the most recent design of 90-in. Niles driving wheel lathe equipped with the "sure grip" drivers, and weighs about 120,000 lbs. The face plates are provided with openings for the crank pins, so that the wheels may by chucked close to the face plates; the movable head is transversed by a 5-h. p. Westinghouse type S motor. The distance between the face plates may be varied from 6 ft. 8 ins. to 9 ft. The swing over the bed is 92 ins.; the diameter of the face plate is 90 ins., and the machine will take wheels from 50 to 84 ins. in diameter without changing the position of the carriages. It is driven by a 40 h.-p. Westinghouse type S motor, having a speed variation of from 1 to 2, which, when combined with changes by gearing, provides cutting speeds of from 10 to 25 ft. per minute on all diameters from 48 to 84 ins. During the test as much as 58 to 60 h.p. was required at times to drive the machine. The cutting speed varied from 8 ft. 6 ins. to 14 feet per minute, most of the work being done at 12 ft. 9 ins. per minute.

The tools used are quite similar to those used at the Angus shops, and illustrated on page 56 of this issue. Where no hard spots were encountered the wheel was turned complete in from 21 to 23 revolutions, divided about as follows: Eight or nine for the roughing cut on the tread, three across the top of the flange, and one revolution each to rough down the front and back of the flange; this was all done with one setting of the tool. The scraper was then applied to the tread of the wheel, smoothing it up in two revolutions; two revolutions were required for cutting the outer bevel and chamfering the outside corners of the tread, and two on each side for finish-

TEST OF NILES 90-INCH DRIVING WHEEL LATHE. MIDVALE TIRES—WEST ALBANY SHOPS, NEW YORK CENTRAL LINES.

Date	Diam. of Wheel, Ins.	Kind of Tool.	Size of Tool, Ins.	Speed Feet per Minute.	Feed per Revolution Ins.	Depth of Cut, Ins.	Distance Traveled, Ins.	Condition of Tool	Time Used—Minutes: Putting Wheel in & Fastening.	Cutting.	Taking out Wheel.	Total.
[illegible]	50	Rex—A [illegible] Rex—A	3x1½ 3x1½ 3x1½	12 ft. 9 in. 12 ft. 9 in. 12 ft. 9 in.	15-32 15-32 15-32	5-16 1-4 1-4	[illegible] [illegible] 2-¾	Good. Point burnt off. Good.	7	39	3	49
[illegible] 18--'05	50	Rex—A Mushet	3x1½ 3x1½	12 ft. 9 in. 12 ft. 9 in.	15-32 15-32	7-16 7-16	5-¾ 5-¾	Good. Good.	7	40	3	50
12--18--'05	50	Rex—A Rex—A	3x1½ 3x1½	12 ft. 9 in 12 ft. 9 in.	15-32 [illegible]	5-16 5-16	5-¾ 5-¾	Good. Good.	7	41	3	51
[illegible]	57	Rex—A Mushet Rex—A	3x1½ 3x1½ 3x1½	12 ft. 9 in. 12 ft. 9 in. 12 ft. 9 in.	15-32 15-32 15-32	1-2 1-2 1-2	5-¾ 1-½ 4-¼	Good. Point burnt off. Good.	8	41	4	56
[illegible] 18--'05	57	Rex—A Rex—A	[illegible] 3x1½	12 ft. [illegible] 12 ft. 9 in.	15-32 15-32	7-16 7-16	5-¾ 5-¾	Good. Good.	7	42	3	52
12--19--'05	57	Rex—A Midvale Rex—A	3x1½ 3x2 3x1½	12 ft. 9 in 12 ft. 9 in. 12 ft. 9 in	15-32 15-32 15-32	5-16 7-16 7-16	5-¾ 15-32 5-9-32	Good. Point burnt off. Good.	6	45	2	53
[illegible] '05	57	Rex—A [illegible] Rex—A	3x1½ [illegible] 3x1½	12 ft. 4 in. 12 ft. 4 in 12 ft. 4 in	15-32 15-32 15-32	7-16 7-16 7-16	[illegible] 2 3-¾	Good. Point burnt off. Good.	7	46	2	55
[illegible]	[illegible]	Rex—A Rex—A	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]	9-16 [illegible]	5-¾ 5-¾	Good. Good.	8	44	2	[illegible]
[illegible]	[illegible]	[illegible] [illegible]	[illegible] [illegible]	11 ft. 8 in. 11 ft. 8 in.	15-32 15-32	1-2 1-2	[illegible] [illegible]	Good. Good.	7	43	2	[illegible]
12 [illegible]	[illegible]	Rex—A Rex—A Rex—A	[illegible] 3x1½ [illegible]	12 ft. [illegible] 12 ft. 3 in. [illegible]	[illegible] 15-32 [illegible]	9-16 7-16 7-16	[illegible] [illegible] 2	Good. Point broken off. Good.	6	42	2	50
[illegible] '05	57	Rex—A Rex—A	3x1½ [illegible]	10 ft. 8 in 10 ft. 8 in.	15-32 15-32	1-2 1-2	5-¾ 5-¾	Good. Good.	6	50	2	58
[illegible]	[illegible]	Rex—A Rex—A Rex—A Rex—A	[illegible] 3x1½ 3x1½ [illegible]	11 ft. 9 in 11 ft. 9 in. 8 ft. 6 in. 8 ft. 6 in	[illegible] 15-32 15-32 15-32	7-16 7-16 3-8 5-16	5-¾ 2 1 [illegible]	Good Point broken off. Point broken off. Good.	6	52	2	60
[illegible] 19--'05	57	Rex—A Rex—A	[illegible] 3x1½	11 ft. 11 ft	15-32 15-32	1-2 1-2	5-¾ 5-¾	Good. Good	7	47	2	56
12--19--'05	72	Rex—A Rex—A	3x1½ 3x1½	14 ft 14 ft	13-32 [illegible]	3-8 3-8	5-¾ 5-¾	Good. Good.	8	46	2	56
12--19--'05	72	Mushet Mushet	3x1½ 3x1½	14 ft. 14 ft	13-32 13-32	5-16 7-16	5-¾ 5-¾	Good. Good.	7	43	2	52
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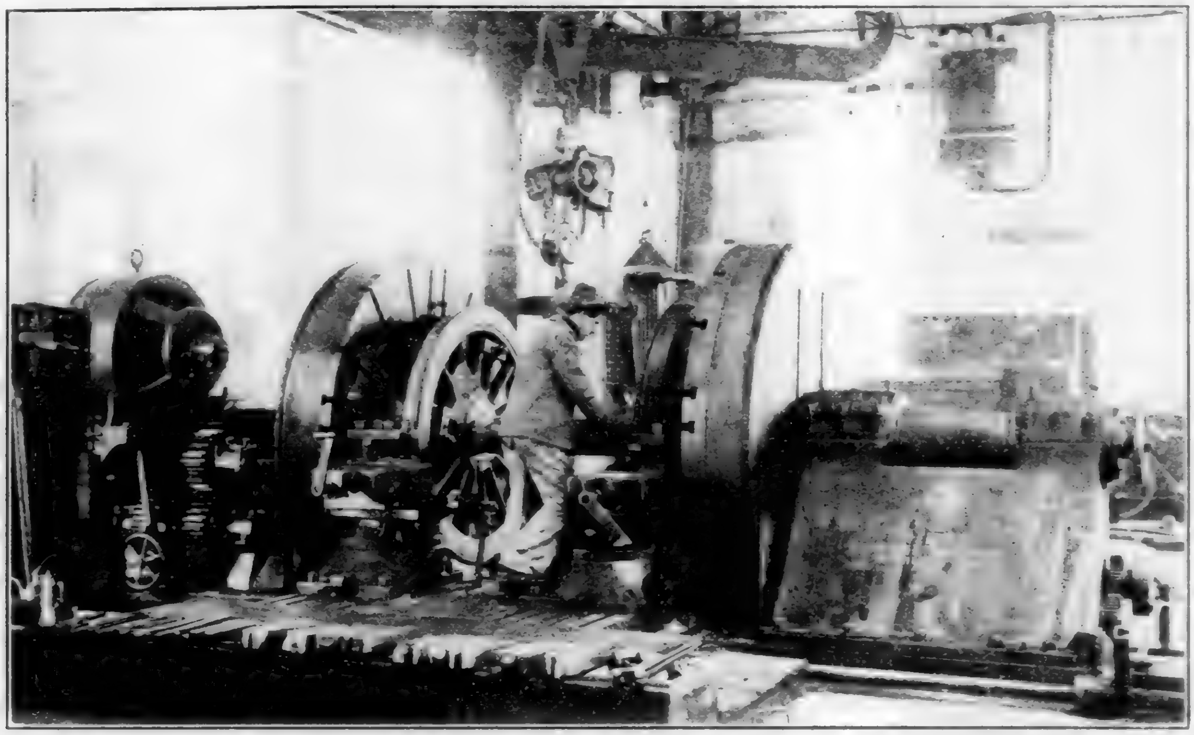

NILES 90-INCH DRIVING WHEEL LATHE—WEST ALBANY SHOPS.

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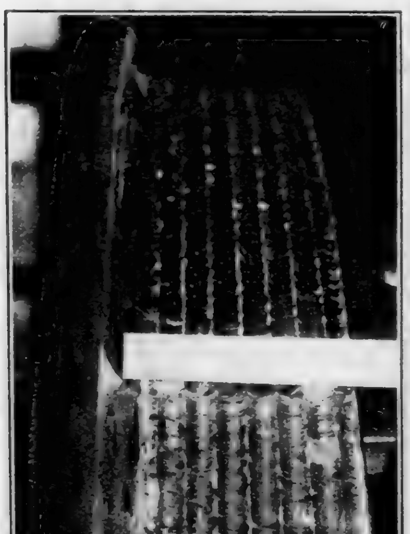
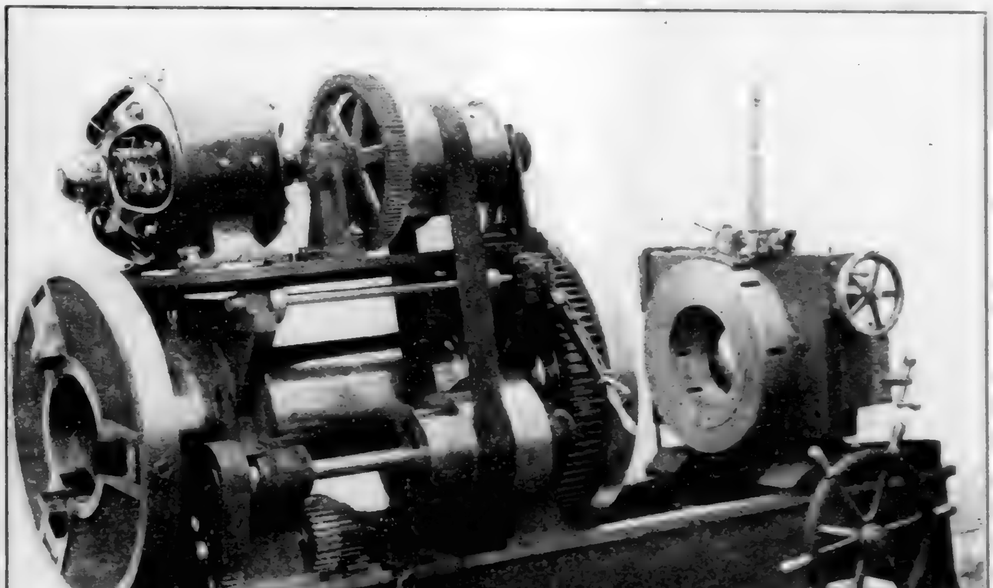


SHOWING ROUGHING CUTS TAKEN ON TREAD OF TIRE AT WEST ALBANY SHOPS.

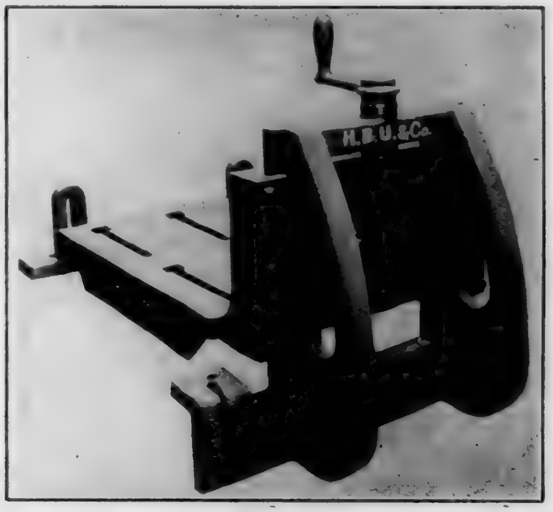


IMPROVED PIPE THREADING AND CUTTING OFF MACHINE.

off tool and the steady slides, the latter being equipped with interchangeable steel facings, are placed on the back of the die stand. An automatic oil pump, placed in the bed of the machine, delivers oil directly to the dies and the cutting-off tool. In addition to the three speeds which may be obtained by the cone pulley, an additional set of speeds may be obtained by means of a compound shifting gear. The gears are all machine cut from solid metal. The machine shown in the illustration is equipped with a 5-h. p. constant speed motor. Quite frequently they are driven by variable speed motors with reversible controllers for cutting left hand threads. The machine weighs about 9,000 lbs.

LATHE ATTACHMENT FOR BORING.

The attachment illustrated herewith may be bolted to the carriage of an engine lathe, thus converting it into a horizontal boring machine. It may be made to suit any size lathe. To place it in position, it is first necessary to remove the tool slide and drill and tap two holes in the back of the carriage. The housing is then fastened at the back of the carriage by the two tap bolts and by additional bolts which fit in the T slots and pass through the flange which projects over the top of the end of the carriage. The table, or shelf, to which the work is



LATHE ATTACHMENT FOR BORING.

APPLICATION OF LATHE ATTACHMENT FOR BORING.

fastened is in the form of an angle plate, the shorter flange of which is fitted to the slides on the housing. This table may be adjusted vertically by means of the large screw. After it has been adjusted to suit the work, it is bolted at the front to the slotted angle irons which are attached to the carriage by bolts fitting into the T slots on the carriage, as shown. Where heavy boring is to be done, it is desirable to use a 3 or 3¾-in. boring bar, attaching one end to the face plate and the other end in a steady rest, or other suitable bearing. For lighter work the bar may be held between the lathe centers. This device, arranged for a 30-inch lathe, is 31 ins. long, 22½ ins. wide, has a vertical adjustment of 5½ ins. and weighs about 685 lbs. It is made by H. B. Underwood & Company of Philadelphia.

MOTOR DRIVEN PORTABLE GRINDER.

The illustration shows a portable motor-driven grinder built for all kinds of internal and external grinding. Power may be taken from a line supplying incandescent lights, connection being made by means of an ordinary lamp socket. When lathe centers are being ground, the compound slide is used; this is operated by means of a rack and pinion, and is set at an angle of 30 degrees, with the center line of the lathe spindle

MOTOR DRIVEN PORTABLE GRINDER.

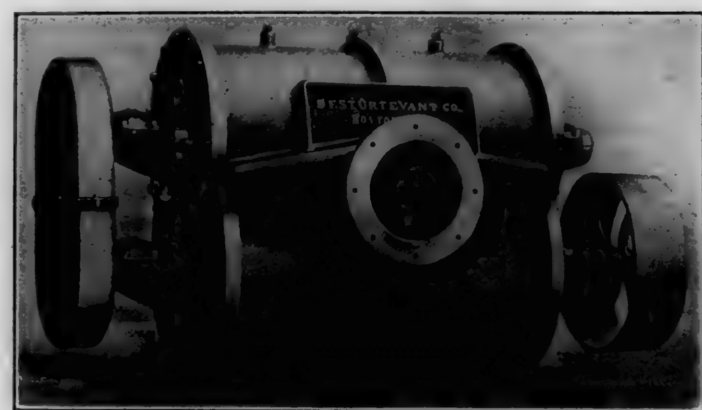
so that it will grind centers to a 60-degree angle exact without the use of the compound slide. This grinder may be placed on the tool slide of any lathe and may be used for internal grinding by mounting the small arbor and wheel in place of the larger wheel. Vertical adjustment is provided to bring the spindle up to the center line of the lathe spindle. The small rest is used for trueing up emery wheels and for sharpening cutters, saws, etc. Provision is made for taking up the slack in the belt, also to take up the wear on the spindle and protect it from the dust. This device is made by the Mueller Machine Tool Company, Cincinnati, Ohio.

STURTEVANT HIGH PRESSURE BLOWER.

The Sturtevant high-pressure blower is made in two types: in the horizontal the two shafts lie in a horizontal plane, while in the vertical, one shaft is above the other. The blower consists of a cast-iron shell, or housing, in which are two rotating members, or "rotors." One of these, the impeller, revolves in the larger portion of the casing, which, in the vertical type, is the lower. It does the real work of compression. The other rotor, known as the idler, does no work; it successively provides spaces or chambers of proper shape at the desired points in the revolution, so that the impeller blades

may return to the suction side of the blower without allowing the escape of compressed air.

Ample clearance between the rotating members and the casing insures high mechanical efficiency by absolutely preventing internal friction due to contact of metal surfaces. The idler, or drum, revolving in the smaller part of the casing, which, in the vertical type, is above the impeller, is symmetrical and has a periphery nearly a complete circle. It consists of three hollow vanes or blades cast in one piece with the shaft, which is of cast iron. The idler, revolving with large clearance, is turned at the same speed as the impeller by means of two spur gears running in oil and incased for protection against dirt and accident. The impeller, mounted on the driving shaft, is made up of three diamond-shaped bars



STURTEVANT HIGH PRESSURE BLOWER.

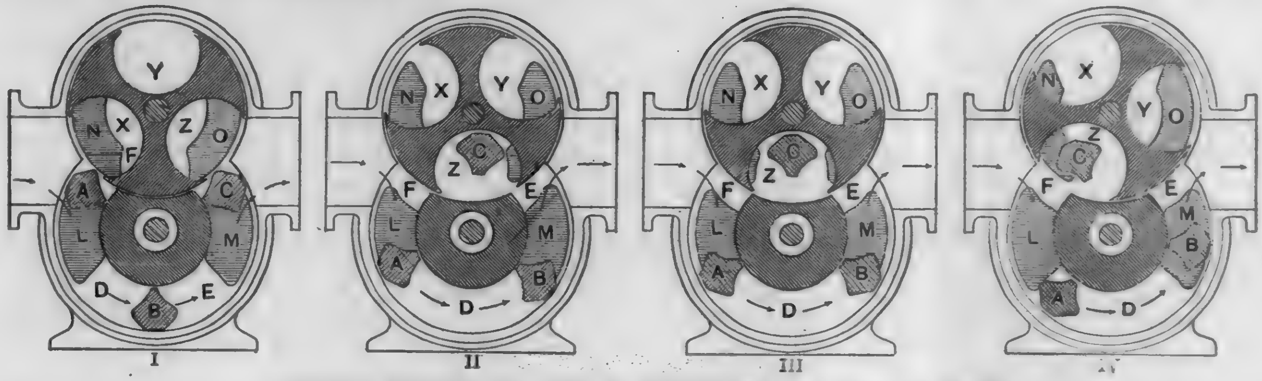


DIAGRAM SHOWING OPERATION OF STURTEVANT HIGH PRESSURE BLOWER.

or blades and a central web, which is keyed to the steel shaft. As it revolves three separate pockets are formed in the annular space between the shell and a core extended lengthwise of the lower part of the casing. In reality the core is in two parts, each cast in one piece with the end plates, the space between them allowing the web to revolve.

The cast iron shell or casing, consisting of two hollow cylinders partially intersecting, is accurately bored. The ends of the casing are finished to receive the four cover plates, in which are cast chambers or passages for lessening the noise, and increasing the efficiency of the machine, as is explained later. On either side of the housing are openings for the intake and the discharge of the air, flanged and tapped for standard gas pipe fittings; the small sizes have openings at the sides, and the large blowers openings at the top and bottom. In every respect the casing and rotors are symmetrical, permitting the blower to run in either direction. Except in blowers of large size, the lower half of each journal box is cast in one piece with the cover plate, insuring rigidity, simplicity and correct alignment. When it is desired to maintain absolutely constant pressure, the blower is provided with a relief valve, or automatic governor. For transferring gases and air at high-pressure stuffing boxes are provided for the shafts, and a drain in the bottom removes tar and other distilled liquids.

OPERATION.

Air at atmospheric pressure entering the blower at the intake is successively imprisoned in the three pockets formed by the three blades of the revolving impeller, and discharged at any desired pressure up to 10 lbs. per square inch. The volume of free air delivered varies directly with the number of revolutions; the pressure varies with the resistance met in the delivery pipe. The principle upon which the blower operates is clearly shown by the accompanying diagrams, which are sectional views of the rotors and casing. In the explanation it is assumed that the blower is running at a speed to produce average pressure, and that this pressure exists in the discharge outlet.

While the rotating members are in the positions shown in Fig. 1, air enters freely and completely fills the chambers X and D, while pockets E and Z are discharging air to the delivery pipe. From the previous movement of the rotors, the pressure in Y, filled with air carried over by the revolving idler, had been increased slightly by air flowing through the leakage passage N, as will be explained later. The space between blades A and C, just above the concave portion of the core, is practically filled by the wing of the idler, and consequently while in this position it takes no part in the action.

While revolving from the position of Fig. 1 to that shown in Fig. 2, the air in pocket D has been carried along, and the communication between chamber D and the inlet has been cut off. Space Z is filled with compressed air, which further movement will carry toward the suction end, where it will flow back to the inlet and in escaping cause noise. But this noise and loss is prevented by the leakage chamber O, which allows the pressure to be transmitted to the air in space Y, thereby increasing its density just before it is discharged.

DETAILS OF STURTEVANT HIGH PRESSURE BLOWER.

Continued rotation carries the rotors to the position shown in Fig. 3; air at atmospheric pressure is now entering pocket F, the air in D is being carried around between the blades A and B in the annular space, and E is discharging. Above the impeller the remaining pressure in Z is being transmitted to the air in X by means of the leakage passage N provided for the purpose, thereby making its pressure slightly greater than atmospheric. The air in space Y under slight pressure from previous leakage is imprisoned and being carried around by the idler.

When the fourth position is reached pocket F will be filling,

the pressure in chamber Z will have been reduced to atmospheric by leakage, space Y will discharge, and a little compressed air from the delivery pipe will flow back through leakage passage M and increase the pressure in D, which will result in a quieter discharge when further movement brings B into the discharge passage.

The purpose and advantage of the leakage passages is now apparent; they make it possible to recover the pressure tending to escape from the impeller pockets, and by making the increase in pressure gradual cause the blower to run with less noise. Leakage passage L has little effect when the blower runs in the direction shown here; it is made to allow the blower to be reversible. It will be noticed that the impeller carries three blades, set at equal distances around the periphery, thus causing three admissions of air at each revolution. Upon leaving the position shown in Fig. 4 the rotors quickly reach a position in which the conditions are exactly the same as those shown in the first figure, the operation continuing as explained.

PEN-DAR METAL LOCKER.

Within the past three years metal office furniture and fixtures have proven their worth so strongly that at the present time an office or factory to be considered thoroughly up-to-date must have its equipment, such as lockers, filing cabinets, cases, tables, etc., made of sheet steel. In comparison with wood as material for such furniture, steel possesses every advantage. Its use means greater convenience and economy; it enforces more system and saves employees' time; it encourages neatness and cleanliness, prevents waste and gives increased protection against fire.

Several state legislatures have passed laws to the effect that nothing but steel equipment shall be used in offices where valuable records and documents are filed, even going to the

PEN-DAR METAL LOCKER.

extreme measure of condemning the present wood fixtures. Our banks, insurance companies and large corporations are rapidly realizing the importance of this question, and architects and engineers are gradually beginning to admit the fact that no matter if a building is constructed of fire-proof material, it is not fire-proof when filled with a great mass of wooden fixtures.

The experimental stage has gone by and the future will see our fire-proof buildings not only fitted with steel lockers, vaults and cabinets, but, in short, every movable piece of furniture will be of metal. To corporations employing a large number of men, one of the main requisites is clothes lockers and, where space is valuable, the installation of this important equipment is a matter of much thought. Being made entirely of open mesh, the metal locker allows a free circulation of air, in consequence of which it is well ventilated and sanitary. Moreover, the contents of each individual locker can be thoroughly inspected at any time. They can be easily fumigated without the articles in the locker being removed. They are germ-proof, fire-proof and time savers.

A complete line of metal furnishings, known as the "Pen-Dar" system, is made by Edward Darby & Sons' Company, Inc., of Philadelphia; these manufacturers include in their system such specialties as metal lockers, shelving, partitions, tables, cabinets, etc. The Pen-Dar metal lockers are made in groups and sizes, according to requirements or specifications, and can be made entirely of open mesh or of sheet steel and on the "unit" system.

The new Pen-Dar expanded metal locker is made of expanded metal by a new process, patented under date of April 25, 1905. This metal is made from a sheet of planished steel plate, cut, expanded, and then rolled in such a manner that it presents a smooth surface entirely free from rough edges or corners. Each locker is equipped with one shelf, three nickel-plated coat hooks, individual brass number plates and a special three-point locking device, which securely fastens the door at the top, center and bottom with a single turn of the locking lever. All locks are provided with two non-changeable keys, and each set is master keyed.

ELECTRIFICATION OF THE PENNSYLVANIA RAILROAD.

Up to the present time the principal advance in the electrification of steam roads has taken place at the terminal stations or upon branch roads, so that the recent decision of the Pennsylvania Railroad to equip electrically a portion of their system between Camden and Atlantic City, New Jersey, is of the greatest interest. The developments which have taken place at New York under the direction of the New York Central and the New York, New Haven & Hartford Railroad Companies have focussed the attention of the engineering world on this branch of railroad engineering, and this further advance of electric traction coming, as it does, when this phase of railroading is fresh in the minds of all engineers, marks another milestone passed in the substitution of electricity for steam for railway service.

That portion of the Pennsylvania Railroad to be electrified comprises some sixty-four miles of steam road lying between Camden and Atlantic City, New Jersey, being a portion of the West Jersey and Seashore branch of the Pennsylvania system. It is proposed to utilize the Cape May line of this system from Camden as far as Newfield, this line being double-tracked with 100 lb. rails, and to build an additional track from Newfield to Atlantic City, making the lines double-track throughout. Over this roadbed, an express service will be established. The initial installation will provide for a three-car train every fifteen minutes between Camden and Atlantic City, making the sixty-four miles in eighty minutes without stops. The maximum speed of the cars will be between 55 and 60 miles per hour.

In addition to this through service to Atlantic City, a half-hourly schedule is planned, consisting of two-car trains between Camden and Millville, 40 miles, and ten-minute service of single cars between Camden and Woodbury, 8½ miles. Full service will call for 58 cars in operation, each equipped with two 200 h.p. direct current motors, known as GE-69. These motors will be similar to those now being manufactured by the General Electric Company for the equipments of the New York terminal of the New York Central & Hudson River Railroad. The motors will be controlled by the Sprague-General Electric automatic multiple unit system, which will permit the operation of cars in trains, all of the motors being under the control of the motorman in the cab of the forward car. Current will be furnished to the cars by the third rail system, except on the sections between Camden and Woodbury and Newfield and Millville, where the cars will obtain the necessary current by an overhead trolley. The speed on these sections is less than on the main line.

The power house will be located at Camden. Power for the operation of the cars will be furnished by three 2,000 k.w. General Electric Curtis turbo-generators of the three-phase alternating current type, having a frequency of 25 cycles. From this power house transmission lines will be run to six sub-stations between Camden and Atlantic City, and a seventh sub-station at Millville to supply that section of the road lying between Millville and Newfield. The transmitting potential will be 33,000 volts. At the sub-stations a total capacity of 11,000 k.w. in rotary converters will be provided, delivering direct current to the third rail at 650 volts. The individual units will be of the standard General Electric type, and will have a capacity of 750 k.w. They will be started from the alternating current end by means of taps on the stepdown transformers.

The contract calls for the completion of this road by July 1, 1906, in order to take care of the heavy summer traffic. The total amount of money involved is about $3,000,000. The electrical equipment will be furnished by the General Electric Company.

MOTOR DRIVEN TOOLS AT THE McKEES ROCKS SHOPS.

To the Editor:

On pages 32 and 33 of your January issue you quote certain figures from a paper by the undersigned, read before the Engineers' Society of Western Pennsylvania. The figures for labor cost are rather misleading. They are, apparently, the cost of labor for repairing and building locomotives in the machine and erecting shop, whereas the figures for both years, 1903 and 1904, cover all labor performed at McKees Rocks during those years, which was charged to locomotive repairs, irrespective of whether repairs were made to locomotives in the shop or running repairs in the round house, the latter including replacing of boiler tubes, drop-pit work, stay-bolt work, and the regular running repairs. These charges also include the labor cost on all material made up in the blacksmith shop, boiler shop, machine shop and the cab and tender shop as stock, the labor being charged to locomotive repairs and a large portion of the material being sent to outside points to be applied to locomotives. The actual labor charged against the locomotives shown as undergoing repairs and built in the shops would be, approximately, one-half the figures given, or, say, $110,000 for 1903 and $130,000 for 1904.

The significance of the figures for the two years lies in the fact that, while the cost for running repairs was practically the same during both years, the output in the manufacturing shops was more than doubled, at an increase of only $20,000 in the payroll. I will be very glad if you will give this letter prominence, as the figures, as they appeared in the article above referred to, would indicate that the cost of labor for locomotives undergoing general overhauling was entirely too high. G. M. Campbell.

Baldwin Locomotive Output.—During the year 1905 the Baldwin Locomotive Works turned out 2,250 locomotives. Of this number 140 were electric and 115 were compound, mostly of the balanced type, although there were a few tandem compounds among the number; 406 were for export. The average number of men employed was 14,811, the works being operated night and day.

PERSONALS.

Mr. W. P. Chrysler has been appointed master mechanic of the Chicago Great Western Railway at Oelwein, Ia., to succeed Mr. J. E. Chisholm.

Mr. F. S. Anthony, formerly of the Atlantic Coast Line, has been appointed master mechanic at Pen Argyl, Pa., to succeed Mr. Shields.

Mr. E. B. Hughes has been appointed general foreman of shops of the Wabash Railroad at Tilton, Ill., in place of Mr. John Baird, resigned.

Mr. C. H. Quereau, engineer of tests of the New York Central & Hudson River Railroad at West Albany, N. Y., has been appointed superintendent of electrical equipment of that road.

Mr. L. S. Storrs has been appointed engineer of tests of the New York, New Haven & Hartford, with office at New Haven, Conn.

Mr. George Schwartz has been appointed foreman of machine shops of the Wabash Railroad at Fort Wayne, Ind., succeeding Mr. Hughes.

Mr. H. C. Shields, former master mechanic of the Lehigh & New England Railway Company, has been appointed superintendent of the same road, with offices at Pen Argyl, Pa.

Mr. A. B. Bardsley has been appointed master mechanic of the Gulf & Ship Island Railroad, with office at Gulfport, Miss., to succeed Mr. M. S. Curley, resigned.

Mr. R. A. Johnson has been appointed master mechanic of the Sonora Railway, with offices at Guaymas, Mexico, vice Mr. S. E. Kildoyle, resigned.

Mr. A. W. Byron has been appointed assistant master mechanic of the Buffalo & Allegheny Valley division of the Pennsylvania Railroad at Olean, N. Y.

Mr. Ellsworth Brown has been appointed assistant road foreman of engines of the Buffalo and Rochester divisions of the Pennsylvania Railroad at Buffalo, N. Y.

Mr. J. E. Chisholm, heretofore master mechanic of the Chicago, Great Western at Oelwein, Ia., has been appointed general master mechanic of that road, with office at Oelwein, Ia.

Mr. J. E. Keegan, heretofore master mechanic of the Grand Rapids & Indiana Railroad, has been appointed superintendent of motive power, with headquarters at Grand Rapids, Mich.

Mr. S. M. Hindman has been appointed general car inspector of the Buffalo & Allegheny division of the Pennsylvania Railroad, with office at Buffalo, N. Y., vice Mr. J. P. Yergy, promoted.

Mr. A. N. Willsie has been appointed master mechanic of the Brookfield division of the Chicago, Burlington & Quincy Railway, with headquarters at Brookfield, Mo., vice Mr. W. W. Lowell, transferred.

Mr. John Hartung, foreman of the car repairing department of the Louisville & Nashville shops in New Decatur, has been promoted to general foreman of the car department of the Nashville-Decatur division and all branch roads.

Mr. J. H. Williams, roundhouse foreman of the Lehigh Valley Railroad at East Buffalo, N. Y., has been appointed master mechanic at Wilkes-Barre, Pa. Mr. Thomas Madigan has been appointed to succeed Mr. Williams at East Buffalo.

Mr. George Dunsmore, foreman of shops of the Erie Railroad at Susquehanna, Pa., has been appointed general foreman of shops of the Buffalo, Rochester & Pittsburgh at Dubois, Pa., in place of Mr. C. S. Diegel, who has been transferred to Rochester, N. Y., in a similar capacity.

Mr. C. Kyle, master mechanic of the Lake Superior division of the Canadian Pacific, has been transferred to the Eastern division at Montreal. He succeeds Mr. J. B. Elliott, recently appointed general master mechanic of lines east of Fort William. Mr. Kyle will be succeeded at North Bay by Mr. G. T. Fulton, formerly general foreman of the Carleton Junction shops.

Mr. A. A. Scott has been appointed locomotive inspector at the Angus shops of the Canadian Pacific Railway at Montreal, Que. Mr. E. Marshall has been appointed locomotive foreman at Outremont, Que., in place of Mr. Scott, and Mr. J. Wilkinson has been appointed locomotive foreman at Hochelaga, Que., to succeed Mr. Marshall. Mr. C. A. Stark, locomotive foreman at Ottawa, Ont., has been transferred to Carleton Junction, Ont., as general foreman.

M. S. Millican has been appointed superintendent of motive power and machinery of the Houston & Texas Central, Houston, East & West Texas, and the Houston & Shreveport, in which capacity he has been acting since the resignation of Mr. S. R. Tuggle about a year ago.

CATALOGS WANTED.

The mechanical engineering department of the Louisiana State University wishes to get together a complete file of manufacturer's catalogs and trade literature. They will greatly appreciate the courtesy if those interested will kindly send literature of this kind to Mr. E. W. Kerr, professor of experimental engineering, Louisiana State University, Baton Rouge, La.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

Extra Heavy Valves.—Jenkins Bros., 71 John street, New York, are sending out a small pamphlet devoted to extra heavy valves for pressures above 150 lbs. per sq. in.

Automatic Slack Adjuster.—The American Brake Company, 1932 N. Broadway, St. Louis, Mo., are sending out a catalogue descriptive of the various forms of the American automatic slack adjusters.

Circuit Breakers.—Circular No. 1107 from the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., is devoted to a description of the different types of the Westinghouse automatic circuit breakers, carbon break.

Planers and Shapers.—Catalog No. 5, from the Hamilton Machine Tool Company, Hamilton, O., describes the various planers and shapers made by them. In addition several pages are devoted to motor applications to these machines.

The Dill Slotter.—The T. C. Dill Machine Company, Philadelphia, Pa., are sending out an interesting catalog describing the Dill slotters. Among other features, they are equipped with a travelling head which greatly increases the range of the machine.

Soft Water.—This is the title of a pamphlet, issued by the Pittsburgh Filter & Manufacturing Company of Pittsburgh, Pa., which is devoted to the question of water softening and a description of the various types and designs of apparatus which this company is prepared to install.

Electrical Apparatus.—Bulletins Nos. 1046, 1047 and 1048, from the electrical department of the Allis-Chalmers Company, are devoted to the Bullock multipolar motors and generators, types H and HI; Bullock oil insulated transformers and Bullock alternating current generators of the engine and fly wheel types.

Combined Pressure and Recording Guage.—"The recording gauge is to the coal pile what the time clock is to the pay roll." This sentence is the introduction to a circular sent out by the American Steam Gauge Valve & Manufacturing Company, Boston, Mass., which considers the advantages of the American combined pressure and recording gauge.

Electric Hoisting Machinery.—Bulletin No. 62, from the Crocker-Wheeler Company, Ampere, N. J., is devoted to electric hoisting machinery. The Crocker-Wheeler standard electric hoists and winches, and also a double drum electric hoist with boom swinging drum are described and illustrations are presented of a number of applications of their motors to hoisting machines of all kinds.

Walschaert Valve Gear, as Applied to Large American Locomotives.—This is the title of a very interesting and important pamphlet published by the American Locomotive Company. It considers briefly the advantages of the Walschaert gear and illustrates several large American locomotives equipped with it, including the heaviest passenger, freight and switching locomotives ever built. Line drawings are introduced showing the arrangement of the gear. The relative weights of the various parts of the Stephenson and Walschaert valve gears for three engines are tabulated and some service results with this gear are presented. In addition there is a specially prepared article, giving a general description, directions for adjusting valves and method of laying-out the Walschaert gear, which was prepared by Mr. C. J. Mellin and reproduced in the January issue of this journal.

Pipe Thawing Apparatus.—This is the title of an interesting folder No. 4051 issued by the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa. Their apparatus for doing this work is described and an interesting table is presented, compiled from actual results, which shows the length of time for thawing different sizes and lengths of pipe under varying conditions.

NOTES.

Wm. B. Scaife & Sons Company.—This company, of Pittsburg, advises that they have received a contract for the structural steel work for the new building of the Southern Bell Telephone Company, Atlanta, Ga.

H. W. Johns-Manville Company.—This company, of New York, announces that Mr. William T. Butler will represent them in the Pacific Coast territory. His headquarters will be at San Francisco, with branches at Los Angeles and Seattle.

Standard Roller Bearing Company.—This company, of Philadelphia, advises that they have just started the erection of a brass and iron foundry, 60 by 125 ft., two stories in height. Their new crucible steel casting plant was put in operation last December.

The Ingersoll-Rand Company.—This company, of New York, announces that they have secured exclusive control of the products of the Imperial Pneumatic Tool Company, with shops at Athens, Pa. This line of tools is well known and includes pneumatic hammers, drills, riveters, reamers, hoists and plug drills.

Railway Appliances Company.—Mr. James L. Pilling has become associated with the Railway Appliances Company, of Chicago, and they will be pleased to receive inquiries relative to improved compressed air locomotive turntable devices and also portable and stationary hoisting engines for all purposes, all being equipped with the Pilling improved engines.

Weir Frog Company.—This company, of Cincinnati, announces that the Louisville and Nashville Railroad has contracted with it for the supply of all frogs and switches for 1906. This is a practical testimony as to the excellence of the Weir Company products and facilities, since it is the renewal of a contract held continuously since this company moved into its plant at Norwood.

Foote, Burt & Company.—This company, manufacturers of multiple drills at Cleveland, announce that they have purchased the plant, patterns, and good-will of the Reliance Machine & Tool Company, manufacturers of bolt cutters, bolt pointers and nut tappers. The plant will be removed to the present quarters of Foote, Burt & Company, making necessary an addition of about one-third more floor space than now occupied by them. The shop-men will be given employment, although none of the executive staff of the Reliance Machine & Tool Company will be retained.

The Kempsmith Manufacturing Company.—This company, of Milwaukee, Wis., announces that the work on the 75 by 45 ft. two story addition to their works is being rapidly pushed and that they are installing a new Corliss engine which will double the power capacity of the plant. The heavy demand for their improved types of milling machines is making it necessary to add a large amount of new equipment for their manufacture.

Chicago Pneumatic Tool Company.—This company, of Chicago, announces that the demand for their air compressors is such that they are making arrangements to increase the capacity of their works at Franklin, Pa., to give an annual output of between 650 to 700 compressors instead of 400 which was the output for 1905. Considerable business was lost during 1905 because of inability to make deliveries. They also announce that they have been awarded the gold medal at the Liege Exhibition for their pneumatic tools and appliances and a silver medal for the Franklin air compressors.

The American Blower Company.—This company, of Detroit, reports that it is furnishing mechanical draft apparatus for the Huntsville (Alabama) Railway Light & Power Company; the New York, Susquehanna & Western Railway Company at Rochelle Park, N. J.; the C. B. & Q. Railway Company at St. Paul and Chicago; the Lackawanna Coal Company at Olyphant, Pa., and the Lehigh Coal & Navigation Company at Lansford, Pa. They are also furnishing heating apparatus for some of the Pennsylvania Railroad Companies' new shops at Allegheny; for the Lincoln Park shops of the B. R. & P. Railway at Rochester; Kingsland (New Jersey) shops of the Delaware, Lackawanna & Western, and for the Schenectady Works of the American Locomotive Company.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

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EAST ALTOONA FREIGHT LOCOMOTIVE TERMINAL.

PENNSYLVANIA RAILROAD.

II.

ROUNDHOUSE.

The roundhouse is in the form of a complete circle, and has 52 divisions, or stalls, 90 ft. deep; two of these divisions are used for a passageway through the house (Fig. 1, page 46). These passageways are in the form of tunnels, have brick walls, and divide the inside of the house into two parts. The foundations of the house are of concrete, the walls are of brick with a steel frame, and the roof is supported by steel trusses and a row of columns 25 ft. from the outer wall. Four-ply slag roofing is laid on 2-in. T and G white pine. The distance from the center of the turntable to the center of the outside row of columns is 197 ft. 7⅞ ins., and the diameter over the foundations is 396 ft. 11¾ ins. The distance between the centers of the columns of the inner wall is 13 ft. and of the outer wall 23 ft. 10⅝ ins.

The construction of the building is clearly shown by the cross section, Fig. 19. This cross section is quite different from that of any other roundhouse previously constructed, although the locomotive heads outward, as is the usual custom. It was the intention to have a 12½-ton travelling crane on a circular runway serve the main or inner portion of the house, which is 65 ft. wide. This crane, which was to have a span of about 62 ft., has never been installed, although it can readily be added by erecting the supplementary crane columns, as shown in the drawing. The use of the crane made necessary a height of 30 ft. from the floor to the underside of the roof trusses, and this large amount of head room and the lantern at the center of this portion of the roof provide splendid ventilation. As a very large portion of the side walls is of glass, as shown in Figs. 17 and 18, the daylighting is excellent.

The outer part of the house is 25 ft. wide from center to center of the columns, and measures only 18 ft. from the floor to the underside of the roof trusses. While it is of rather unusual design to have the locomotive's front end under the lowest part of the house, yet the very efficient form of smokejack which is used makes it possible to keep the house comparatively free of smoke. The front end of the locomotive is served by a screw hoist jib crane of 2,000 lbs. capacity, 12 ft. 6 ins. long.

SMOKEJACKS.—The smokejacks, shown in detail in Fig. 20, are of a special form, which has been developed by the railroad after considerable experiment, and are very efficient. They are made of Vitribestos, and were furnished by Paul Dickinson, of Chicago. This material is very light, the moisture does not readily gather upon it, and it is expected that its wearing qualities will prove very satisfactory, although these jacks have not been in service long enough to determine this definitely. The Vitribestos is laid over a framework of 2½ by 2½ by ¼-in. angles, as shown. The opening at the mouth of the jack is 7 ft. long and 3 ft. 1 in. wide, and this tapers to a circle of 3 ft. 1 in. diameter at the roof, or 11 ft. 6 ins. from the mouth of the jack. If the locomotive stops with its stack under one end of this opening the smoke passes off readily and is not deflected downward into the house, as has been the case with broad-mouthed stacks with sharper slopes. The method of carrying the jacks through the roof is an especially good one, as may be seen by reference to the drawing.

ENGINE PITS AND HEATING DUCT.—The cross section of one of the engine pits is shown in Fig. 21. They are 65 ft. long, 3 ft. 11 ins. wide, 2 ft. 6 ins. deep at the front end and 3 ft. deep at the rear end. The front end of the pit is 16 ft. from the outer wall of the house. The walls and the bottoms of the pits are of concrete; the rails are supported on 8 by 12 in. white oak timbers.

The roundhouse is heated by hot air furnished by the Sturtevant system. A hot air duct or tunnel leads from the fan house around the house, just inside of the outer wall. Hot air from this duct enters each pit at the front end and is forced up underneath the engine; there is another opening in the side of each pit at about where the middle of the tender ordinarily stands. The heating duct is 6 ft. wide and 7 ft. 6 ins. deep at its maximum section, and decreases in height as it gets farther away from the fan house. This tunnel also carries all the piping for the roundhouse, which includes a 4 in. pipe for the fire service, a 4-in. pipe for cold water at 100 lbs. pressure, a 3-in. pipe for compressed air, a 4-in. pipe for hot water at 300 lbs. pressure and a 4-in. steam pipe. Between every other engine pit are water, steam and air connections. The hot water at 300 lbs. pressure is used for testing and washing out the boilers. A boiler can be filled with this hot water in 4½ minutes. Connections are placed in each pit so that the engines can blow off into the sewer outside of the house. Half-way between the pits and at a point 6 ft. to the rear of the middle row of columns the floor level is 3 ins. above the top of the rail, and from this point it slopes toward each pit and to meet the level floor at each end of the pits. This part of the floor consists of 2¾-in. yellow pine laid on 4 by 6-in. stringers, resting on ballast and spaced 14 ins. center to center.

A simple and very efficient cast steel track stop, details of which are shown in Fig. 22, is used at the ends of the tracks so that there will be no possibility of the locomotive moving too far forward and breaking through the floor into the hot air

FIG. 17.—PART OF THE ROUNDHOUSE WITH THE OFFICE BUILDING, POWER PLANT, FAN HOUSE AND OIL HOUSE TO THE RIGHT (FAN HOUSE HAS SINCE BEEN CONNECTED TO THE ROUNDHOUSE.)

FIG. 18.—100-FOOT TURNTABLE.

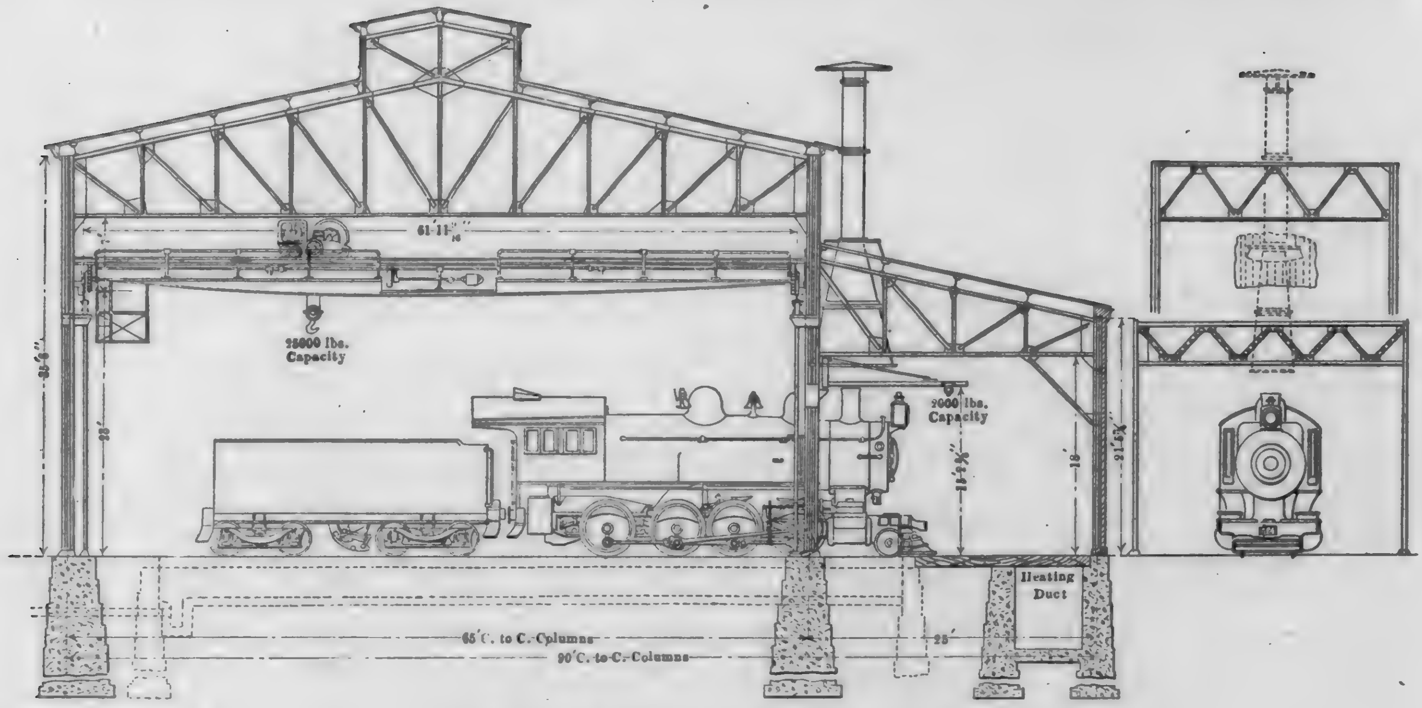


FIG. 19.—CROSS-SECTION THROUGH THE ROUNDHOUSE.

EAST ALTOONA LOCOMOTIVE TERMINAL.

duct. As the minimum distance from the top of the rail to the underside of the pilot is only about 3 ins., and as it is necessary to have the stop at least 5½ ins. high, so that the wheel cannot climb over it, the top of the body of the stop must be made considerably lower than the top of the rail so that the pilot will pass over the highest point.

DROP TABLES.—Four of the pits near the main entrance of the roundhouse and to the machine shop are equipped with drop tables. One of these is 55 ft. long, for use when it is desired to remove a set of driving wheels; one is 24 ft. long for engine truck wheels, and two are double drops, each 8 ft. 6 ins. long, for a single pair of driving wheels. The arrangement of the drop tables for a single pair of driving wheels is shown in Figs. 23 and 24; the driving mechanism is practically the same as for the other tables. The driving wheels are lowered by the rear table until they are level with the track in the pit, they are then rolled forward to the other table and are raised to the surface. A 27-h.p., 220-volt General Electric motor drives the two long shafts, which are supported by adjustable bearings and to which the worms are keyed. Each table is operated by four vertical screws, two right and two left hand. The motor speed is 480 r.p.m., the ratio between the worm and the worm wheel 20 to 1, the pitch of the screw is 1½ ins., and the movement of the table vertically is at the rate of 2 ft. per minute. As the tables are lowered the vertical screws pass down into the pieces of 7-in. pipe which are capped at the lower end and are filled with oil, thus lubricating the screws. These 7-in. pipes are encased in 10-in. pipes set into the concrete. The worm wheels run on roller bearings, and these are carried on center plates with ball joints, so that the screws will not be injured by any side or end movement of the table.

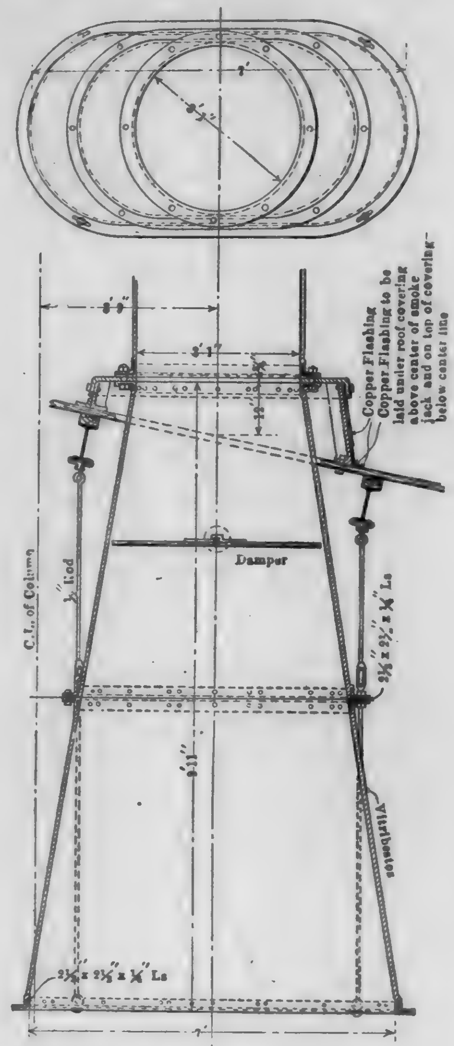


FIG. 20.—SMOKEJACK.

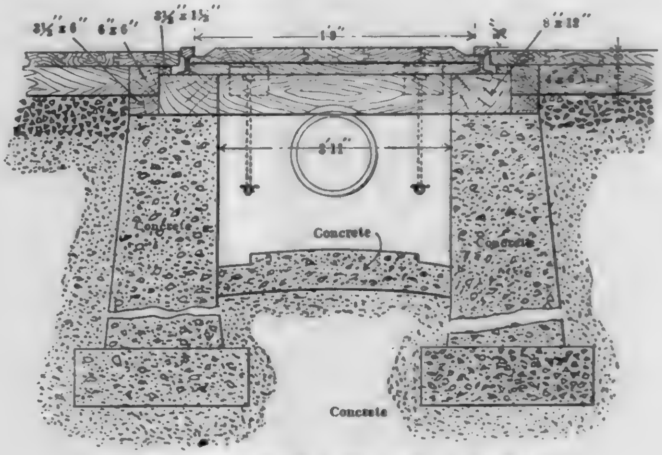


FIG. 21.—CROSS-SECTION THROUGH ENGINE PIT.

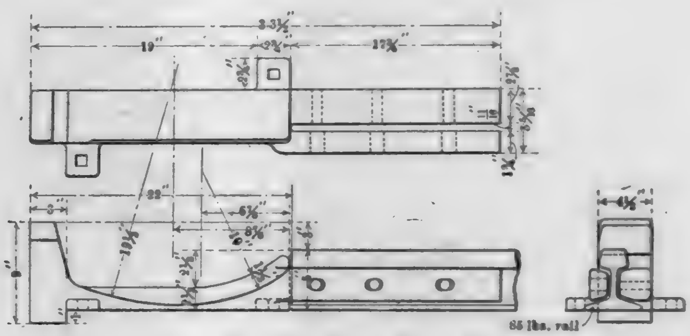


FIG. 22.—CAST STEEL TRACK STOP.

DOORS.—The roundhouse doors are of wood, about 60 per cent. of their area being glass, and they are raised by 4-in. pneumatic hoists with a 16 ft. 5-in. stroke; they are lowered by gravity, the exhaust from the air cylinders being such that they will not drop too fast.

LIGHTING AND HEATING.—Direct current 100-volt arc lamps are used, and in addition each one of the columns in the middle row is equipped with connections for incandescent lights, which may be carried to any part of the engine. The house is heated by the Sturtevant hot air system, the hot air entering the engine pits as described above. An addition to the roundhouse contains two Sturtevant fans, each 12 ft. in diameter by 16 ft. wide, driven by 11½x16-in. engines. These fans draw through two heaters having a combined surface equivalent to

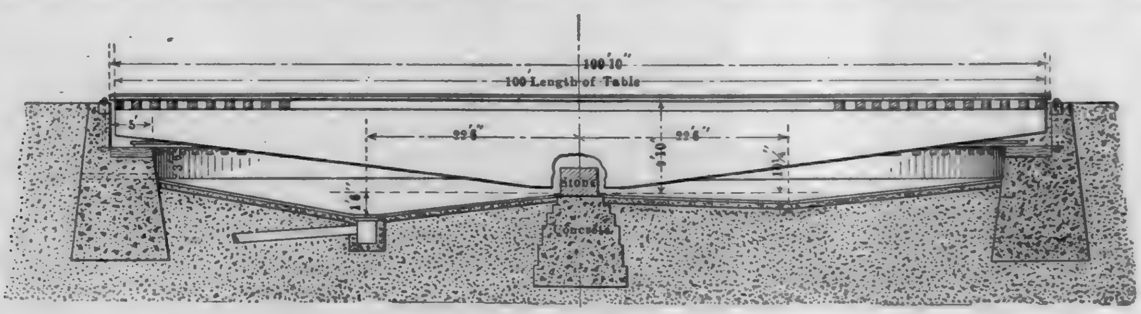


FIG. 25.—TURNTABLE AND PIT.

FIG. 17.—PART OF THE ROUNDHOUSE WITH THE OFFICE BUILDING, POWER PLANT, FAN HOUSE AND OIL HOUSE TO THE RIGHT (FAN HOUSE HAS SINCE BEEN CONNECTED TO THE ROUNDHOUSE.)

FIG. 18.—100-FOOT TURNTABLE.

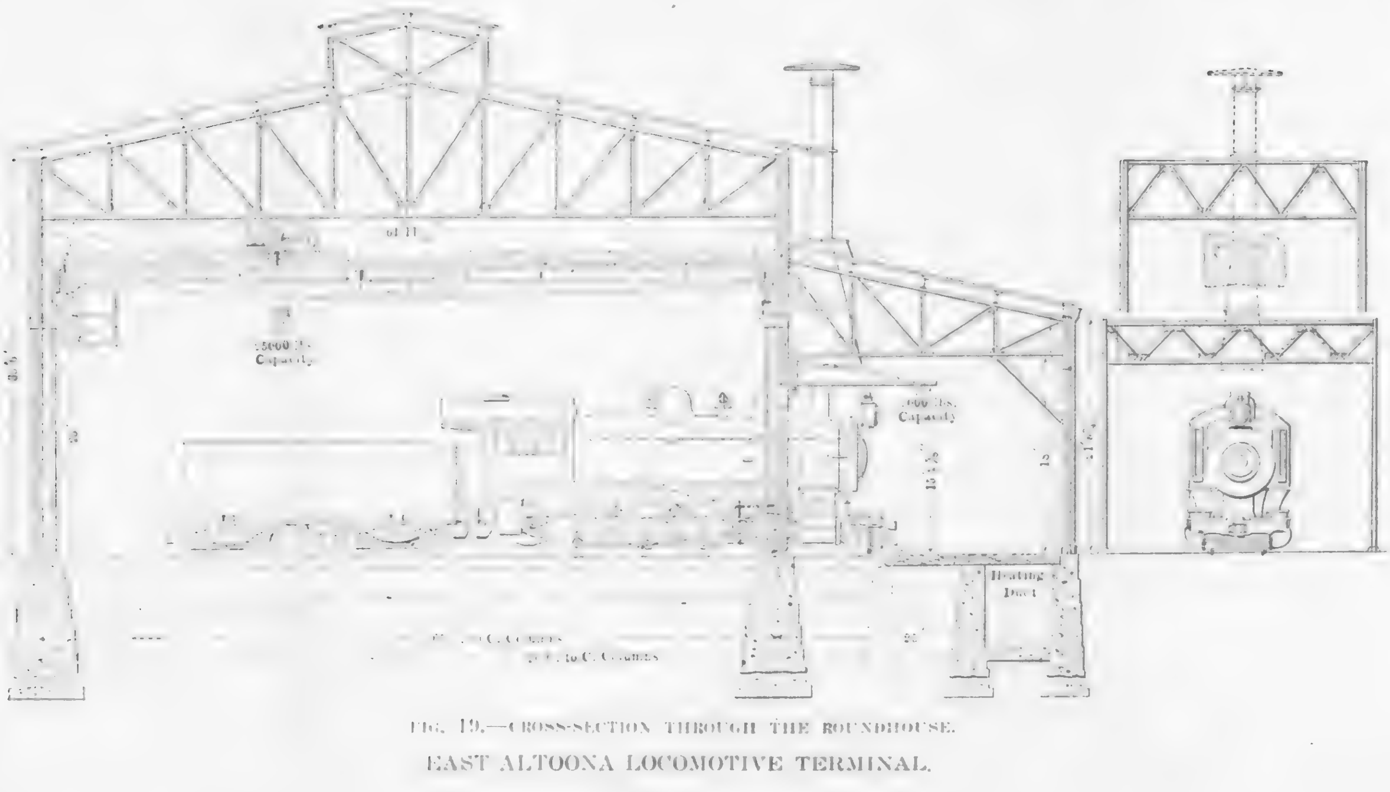


FIG. 19.—CROSS-SECTION THROUGH THE ROUNDHOUSE.

EAST ALTOONA LOCOMOTIVE TERMINAL.

duct. As the minimum distance from the top of the rail to the underside of the pilot is only about 3 ins., and as it is necessary to have the stop at least 5½ ins. high, so that the wheel cannot climb over it, the top of the body of the stop must be made considerably lower than the top of the rail so that the pilot will pass over the highest point.

DROP TABLES.—Four of the pits near the main entrance of the roundhouse and to the machine shop are equipped with drop tables. One of these is 55 ft. long, for use when it is desired to remove a set of driving wheels; one is 24 ft. long for engine truck wheels, and two are double drops, each 8 ft. 6 ins. long, for a single pair of driving wheels. The arrangement of the drop tables for a single pair of driving wheels is shown in Figs. 23 and 24; the driving mechanism is practically the same as for the other tables. The driving wheels are lowered by the rear table until they are level with the track in the pit, they are then rolled forward to the other table and are raised to the surface. A 27-h.p., 220-volt General Electric motor drives the two long shafts, which are supported by adjustable bearings and to which the worms are keyed. Each table is operated by four vertical screws, two right and two left hand. The motor speed is 480 r.p.m., the ratio between the worm and the worm wheel 20 to 1, the pitch of the screw is 1½ ins., and the movement of the table vertically is at the rate of 2 ft. per minute. As the tables are lowered the vertical screws pass down into the pieces of 7-in. pipe which are capped at the lower end and are filled with oil, thus lubricating the screws. These 7-in. pipes are encased in 10-in. pipes set into the concrete. The worm wheels run on roller bearings, and these are carried on center plates with ball joints, so that the screws will not be injured by any side or end movement of the table.

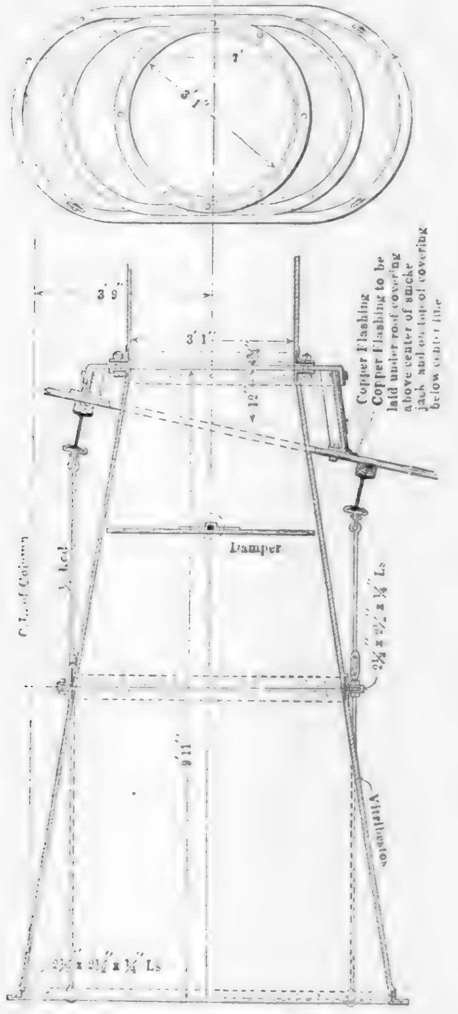


FIG. 20.—SMOKEJACK.

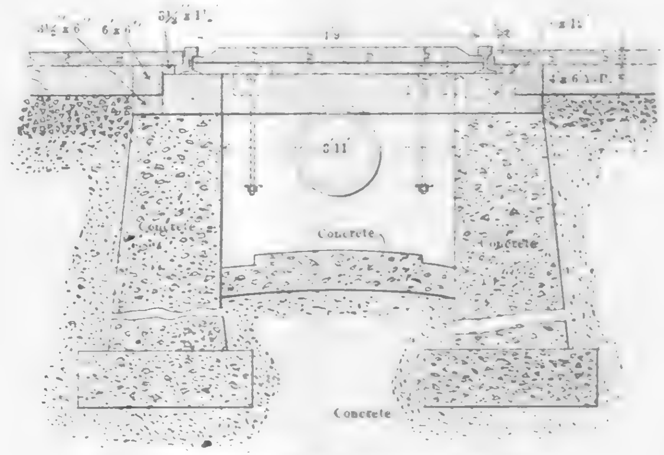


FIG. 21.—CROSS-SECTION THROUGH ENGINE PIT.

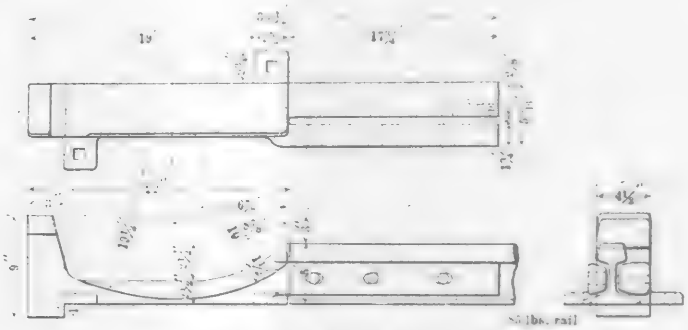


FIG. 22.—CAST STEEL TRACK STOP.

DOORS.—The roundhouse doors are of wood, about 60 per cent. of their area being glass, and they are raised by 4-in. pneumatic hoists with a 16 ft. 5-in. stroke; they are lowered by gravity, the exhaust from the air cylinders being such that they will not drop too fast.

LIGHTING AND HEATING.—Direct current 100-volt arc lamps are used, and in addition each one of the columns in the middle row is equipped with connections for incandescent lights, which may be carried to any part of the engine. The house is heated by the Sturtevant hot air system, the hot air entering the engine pits as described above. An addition to the roundhouse contains two Sturtevant fans, each 12 ft. in diameter by 16 ft. wide, driven by 11½x16-in. engines. These fans draw through two heaters having a combined surface equivalent to

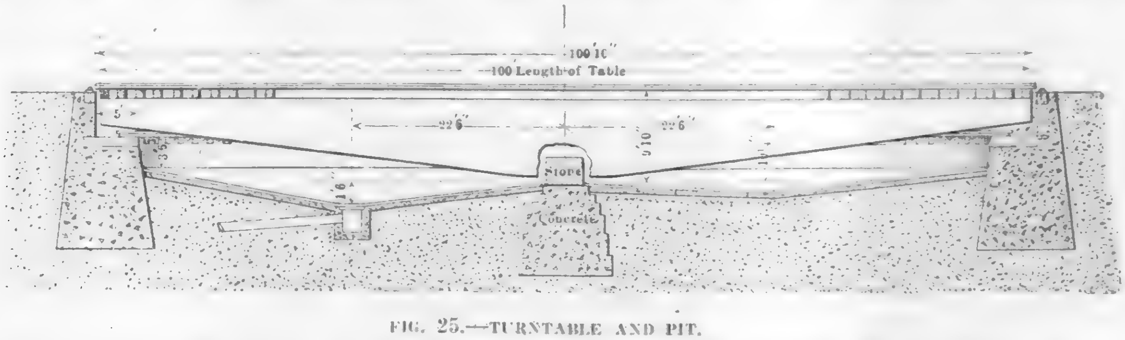


FIG. 25.—TURNTABLE AND PIT.

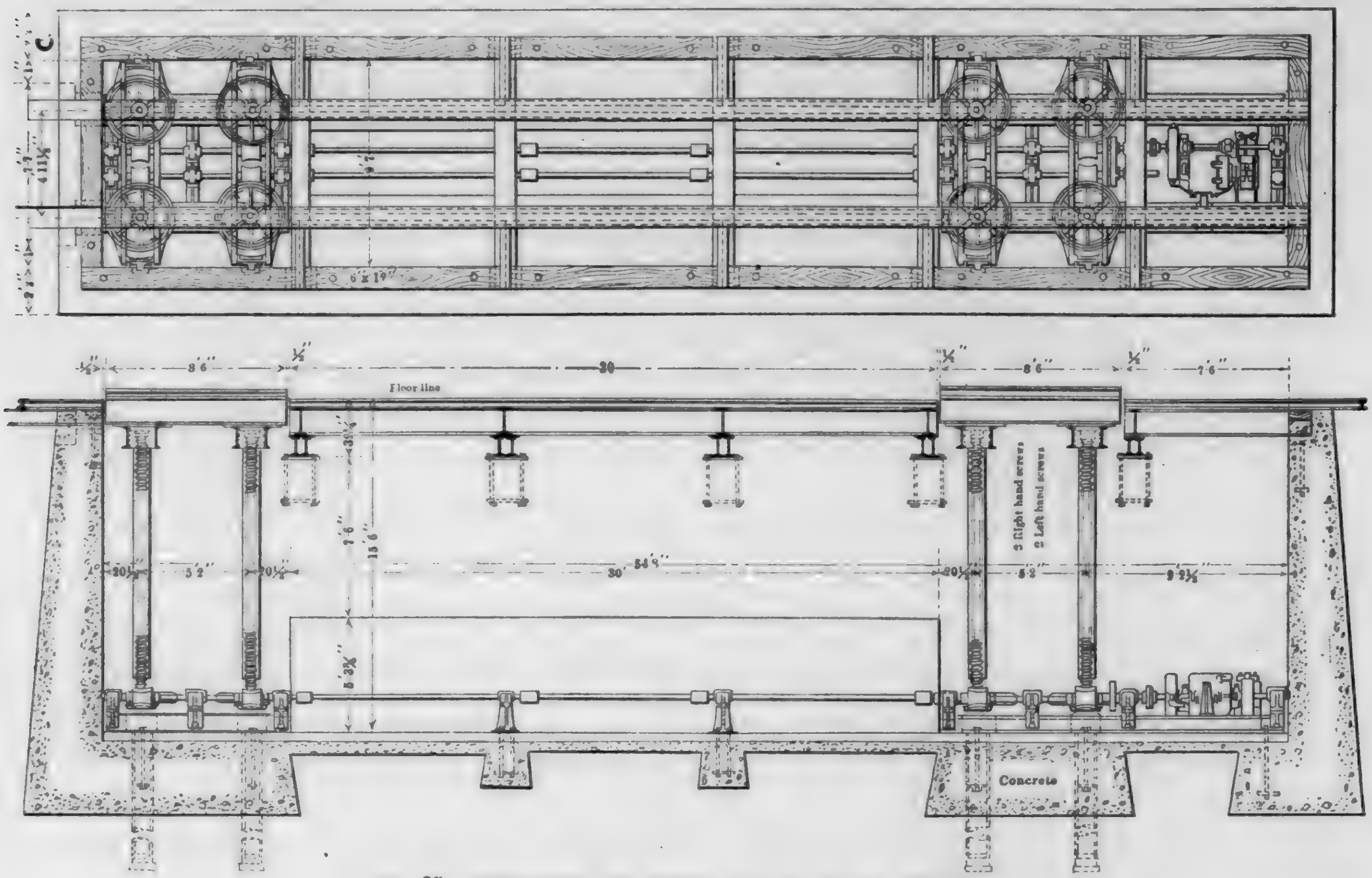


FIG. 23.—DROP TABLE FOR SINGLE PAIR OF DRIVING WHEELS.

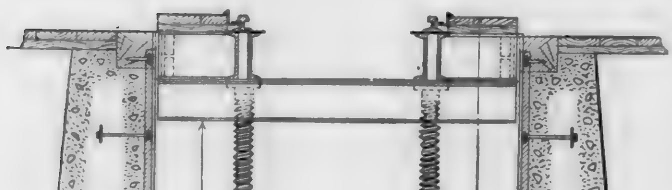


FIG. 24.—CROSS-SECTION OF DROP TABLE PIT.

over 26,000 lineal ft. of 1-in. pipe. The apparatus is designed to change the air in the roundhouse in from 18 to 20 minutes.

The fan house also contains a well 8 ft. in diameter and 24 ft. deep, which drains the heating duct. The water is pumped from this well through a 6-in. discharge pipe into the sewer by means of two centrifugal pumps, which are submerged and are driven by 5-h.p. vertical type motors at the top of the well; these motors operate automatically.

TURNTABLE.—The turntable is 100 ft. in diameter, and is driven by a 12½-h.p., 220-volt General Electric motor. A very important feature of this table is the provision made for the drainage of the pit, which is clearly shown on the cross section of the pit, Fig. 25. The floor of the pit is of brick, laid flat on 6 ins. of concrete, and it slopes downward both from the outer edge and from the center, the lowest point being 22 ft. 6 ins. from the center. The pit is made deep enough, so that a large amount of snow and ice may accumulate without affecting the working of the table. The water is drained off through a 10-in. pipe.

MACHINE SHOP.

The machine shop building, which also includes the flue and smith shops, is 67 ft. 10 ins. by 160 ft. 7 ins. The building has concrete foundations, brick walls with a steel frame, and the roof is supported by steel trusses and columns, as shown in Fig. 26. A 7½-ton electric travelling crane serves the middle bay of the shop. Forty-eight feet at one end of the building is partitioned off from the main shop, and one-half is used for the flue shop and the other half for the smith shop.

On each side of the machine shop there is a 20-h.p. electric motor mounted above the roof trusses, which drives the lighter machinery. Two universal radial drills and two wheel lathes are driven by individual motors. The equipment in the machine shop includes two driving wheel lathes, one of which is used exclusively for turning journals, a planer, shaper, slotter, vertical boring mill, two horizontal boring mills, seven engine lathes, three vertical drills, three universal radial drills, a hydraulic press, bolt cutter, pipe cutter and tool and drill grinders. The smith shop equipment includes a steam hammer and a large double forge. The flue department contains a full set of machinery for repairing and testing flues, and a flue rattler is located just outside of the shop.

POWER HOUSE.

The power house is a steel frame brick building, about 65 ft.

square. It is divided by a 12-in. brick wall into an engine room 22 ft. 10 ins. by 62 ft. 3 ins., and a boiler room 38 ft. 11 ins. by 62 ft. 3 ins. The engine room floor is 6 ins. above and the boiler room floor 7 ft. below the ground level, as shown in the cross section, Fig. 29. The boiler equipment consists of six 60-in. locomotive type boilers, with a total capacity of about 1,000 h. p. Coal is unloaded from hopper cars on the trestle directly on to the boiler room floor. When sufficient ashes have accumulated in the pits they are raked into the ash buckets, which are similar to the one illustrated in Fig. 8, page 48. These buckets are run along a larry track to the outside of the building, where they are unloaded into a car on the siding by means of a pneumatic hoist on a runway which extends out over the track. Supported on a steel frame, above the boilers, is a large tank of 6,000 gal. capacity, which holds the hot water for testing and washing out the boilers and for other purposes. A Cochrane No. 28 special feed water heater supplies this large tank and also the boilers with water at 200 degs. F. There are two 10 by 6 by 10-in. Worthington boiler feed pumps. Two Knowles 8 by 12 by 12-in. vacuum pumps are used in connection with the Webster vacuum return system used with the Sturtevant heating system. The chimney is steel, brick-lined, 6 ft. in diameter and 120 ft. high.

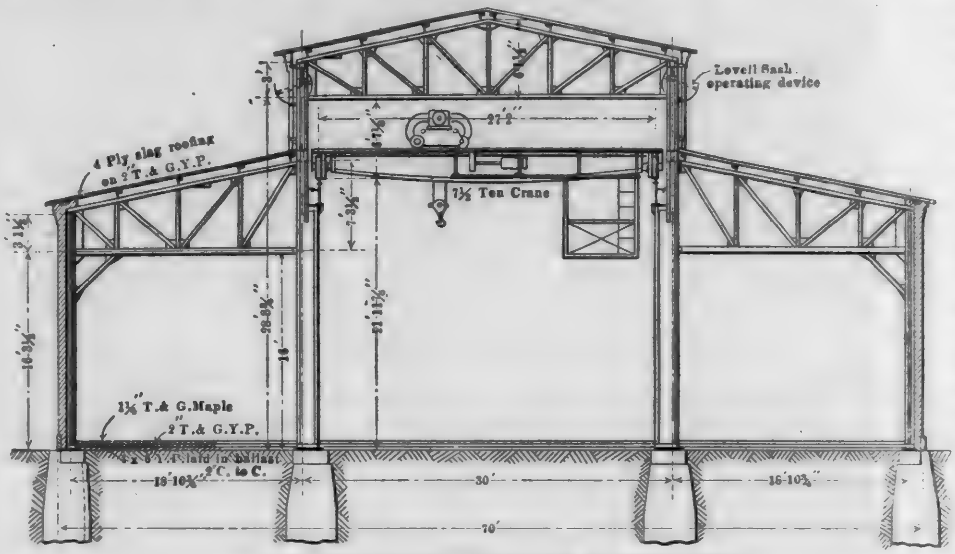


FIG. 26.—CROSS-SECTION THROUGH MACHINE SHOP.

In the engine room are two 11 by 19 by 14-in. tandem compound Ball engines, which are direct connected to 100-k.w., 225-volt General Electric generators. Compressed air at 100 lbs. pressure is furnished by two Ingersoll-Sergeant Class H two stage compressors, with 12 by 12-in. steam and 12 by 18 by 12-in. air cylinders. These are equipped with a water aftercooler, and the air also passes through an atmospheric aftercooler just outside of the house at one end of the engine room. There are two 17 by 18½ by 15-in. Worthington pumps, one of them being used in connection with an accumulator weighted for 300 lbs. pressure (hot water), and the other one is weighted for 100 lbs. pressure. These accumulators have 12-in. plungers and a 10-ft. stroke.

OIL HOUSE.

A transverse section of the oil house is shown in Fig. 30. The basement, 32 by 43 ft., has concrete walls and floor. It contains four 80 barrel oil tanks and six small ones. Oil from the tank cars is delivered to the storage tanks by gravity. The first floor is of expanded metal and concrete, designed for a pressure of 250 lbs. per sq. ft., and supported by I beams and cast iron columns. The upper part of the building is divided into three parts, a sweat room, 17 ft. by 21 ft. 10 ins., which is separated from the other part of the building by a 9-in. brick wall, a waste room 12 ft. by 21 ft. 10 ins., and separated from this by a corrugated steel partition is a drawing room 14 ft. 2 ins. by 21 ft. 10 ins. Oil is drawn from the tanks in the basement by means of compressed air. The roof of the building is of expanded metal and concrete, with a slag finish, and is supported by 8-in. I beams extending lengthwise on the roof trusses.

CLOSET AND LOCKER ROOM.

A brick building, 24 by 106 ft., just outside of the roundhouse and near the machine shop, contains closets, lockers and wash basins for the use of the men employed in the roundhouse and shops. There are one hundred and seventy-five 12 by 12 by 60-in. wire lockers, made by the Wayne Iron Works, and 70 large wash bowls supported by an open steel framework, so that dirt cannot accumulate underneath without be-

FIG. 27.—POWER HOUSE.

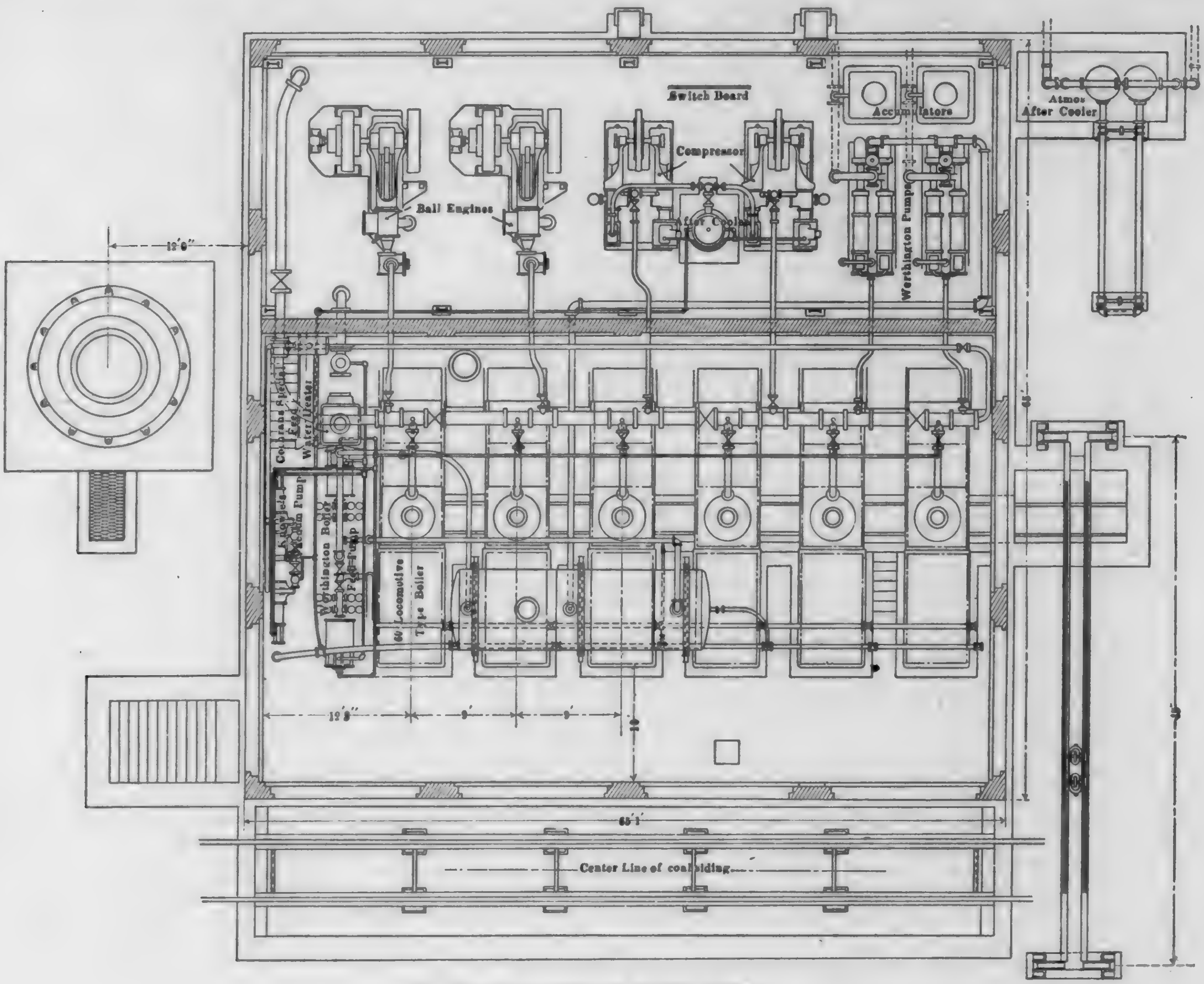


FIG. 28.—PLAN VIEW OF POWER HOUSE.

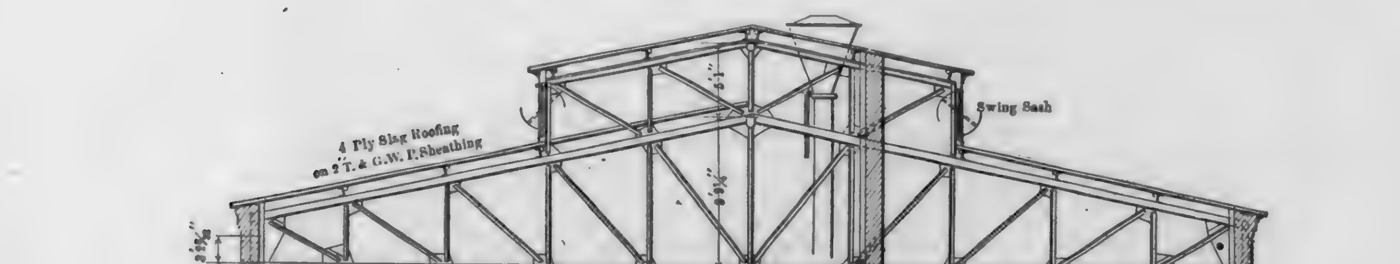


FIG. 29.—TRANSVERSE CROSS-SECTION THROUGH POWER HOUSE.

ing readily detected. The foundations of the building are of concrete and the floor is of reinforced concrete 8⅝ ins. thick, to prevent the floor from cracking in case the ground should settle, as the building rests entirely on filled ground. The roof is supported by light steel trusses.

OFFICE AND STOREHOUSE BUILDING.

A large two-story building, 65 by 161 ft., is used for the offices and storehouse, and the second floor is entirely devoted to the comfort of the engine crews who lay over at East Altoona. The basement has a clear height of 8 ft. 6 ins., has a concrete floor, and is used for the storage of heavy goods. An elevator connects it with the first floor. About three-fifths of the first floor is used as a store room, and the rest is divided into offices for the roundhouse foreman, the engine dispatcher and the road foremen of engines. The second floor contains an airbrake instruction room, 52 by 26 ft., a reading room, 44 by 26 ft., a bathroom, closets and nine bunk rooms containing 74 beds.

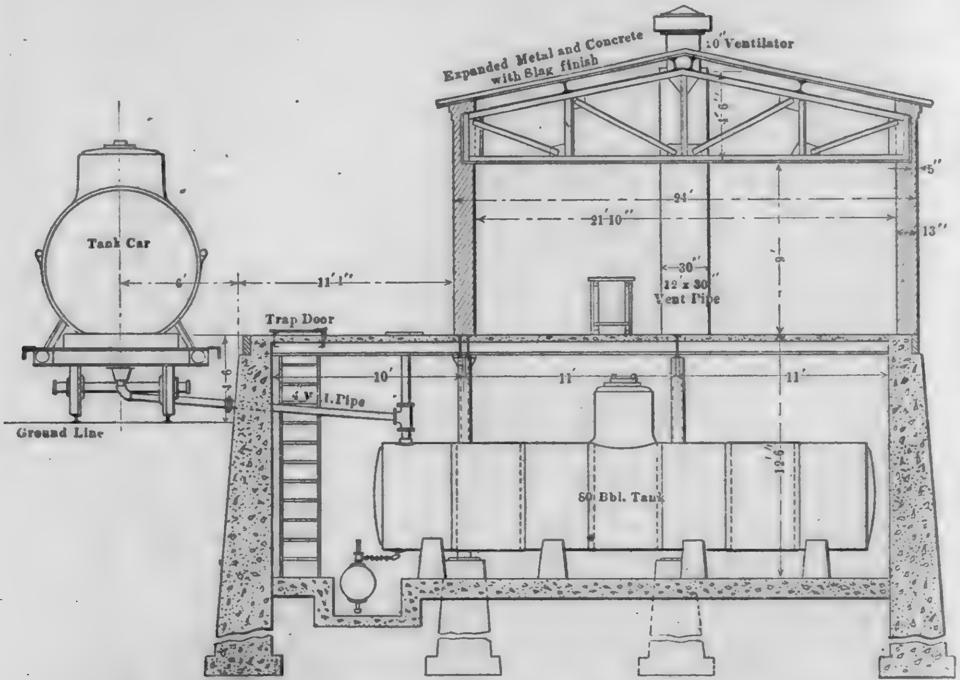


FIG. 30.—CROSS-SECTION THROUGH OIL HOUSE.

RAILROAD EDUCATION.

In a paper on the above subject, read before the St. Louis Railway Club, Prof. Dewsnup of the University of Chicago gives in detail the work which could be accomplished by a Railway College forming part of one of the larger universities. In speaking on the subject he makes the following suggestions:

"It seems to me that two kinds of work need to be carried on, the first and the one of primary importance being the development of facilities for technical training in transportation, granting to the various studies included in the same all the dignity of university teaching and making the transportation school as direct and natural an opening into transportation as the medical and law schools are to medicine and law. The second is the more systematic provision of technical education for the men already in the service, the great majority of whom, for many years to come, must necessarily be without the initial training referred to above. Much may be said in praise of the work accomplished for employes through the railway clubs and the educational branches of the Railroad Y. M. C. A. and in other ways, but more needs to be done, with greater system, and with more pronounced results.

"In connection with this, my proposal is that the railways should directly encourage the extension of transportation teaching at all the large universities.

"One distinctive feature of this college should be the arrangement of the work of its members. The students should follow their classes from the beginning of October until the middle of June, and from that time until the middle of September should be placed on the railroads at a small salary to learn the practical details of the business. They could be used to fill in odd vacancies and, even if they do not accomplish much, they would probably earn the small salary assigned. The combination, in each year of college life, of the theory of the class with the practice of the road would be beneficial both mentally and morally to the student. Any inclination to the 'swelled head,' acquired in the class room, would be knocked out of him most effectually by his associates in employment. During the whole period of the three months, he would be required to submit weekly reports as to the work he was doing, with descriptions of and observations upon the same.

"The courses of the railway college should provide training on five different sides, mechanical engineering, civil engineering, electrical engineering, commercial and operating, all with distinct reference, of course, to railroad work. To effect this, the college should be in close touch with the engineering department of the university, so that courses common to the railroad and general engineering should not need to be handled in the railway college, only those courses coming under its direct charge which bear a distinctly railroad aspect, for instance, railway construction, maintenance of way, locomotive construction, locomotive tests, and so forth.

"The companies would benefit by the leavening influence exerted by the steady influx of able and broad-minded young men, whose training would enable them to see far above and beyond the petty aims and strifes of unregulated unionism, and who would become natural leaders of thought among their associates. Their influence would strengthen good discipline, encourage amiable relations between men and officers, because there would be better understanding of one another's duties and responsibilities. The work of the school would have a direct bearing upon the labor problem as it faces the railroad companies to-day.

"In addition to this work of instruction, the Railway College should become a world-famous center of research work. As its testing plants, appliances and libraries develop, its faculty and advance students, in association with practical railway men, could be constantly devoting attention to the consideration of the improvement of railway facilities in all departments. I should like to see its libraries associated with a bureau of information, which should collect, classify and make readily accessible the results of the investigations of all countries and all investigators on railway subjects."

SCHOOL OF RAILROAD ENGINEERING AND ADMINISTRATION.—The University of Illinois, Urbana, Ill., announces the establishment of a new school of railroad engineering and administration, which will be opened for work in September of this year. This is the first school of this kind to have been established, and it is intended to cover the entire field of railroad service, both engineering and management. In addition to the regular faculty, prominent railroad officials in different departments will deliver special lectures during the course.

Mr. Willard A. Smith, of Chicago, has received from the Emperor of Japan the decoration of the Imperial Order of the Rising Sun, in recognition of his services to Japan while chief of the transportation department of the Louisiana Purchase Exposition.

GASOLINE ELECTRIC MOTOR CAR.

DELAWARE AND HUDSON COMPANY.

That there is an important field of usefulness for an independently driven passenger car is being recognized, is evidenced by the persistency with which the problem of building a special car for this work is being undertaken in different parts of the country. This subject has received longer study and more experiments have been made in England than in this country and there are now a comparatively large number of independently driven motor cars in successful operation on English railroads. A fair proportion of these are steam driven, while others are propelled either by gasoline engine direct or through the medium of an electric generator direct-driven by a gasoline engine and electric motors on the truck.

In this country the latter two systems seem to have been given the greater amount of attention. The most notable example of the former method is the type of motor car used on the Union Pacific Railway, which was illustrated and described in the AMERICAN ENGINEER AND RAILROAD JOURNAL, November, 1905, page 420.

Of the gasoline electric motor cars there have been several different examples constructed and tested, most of them with fairly successful results. This system has many advantages in the matter of easy and efficient control, more rapid acceleration and less difficulties in the operation of the gasoline engine, which can be run at a constant speed instead of being changed as the speed of the car changes, and for those reasons it is being given the greater amount of attention.

GASOLINE ELECTRIC MOTOR CAR—DELAWARE AND HUDSON COMPANY.

One of the latest examples of motor cars of this type was recently built by the General Electric Company and American Locomotive Company for the Delaware and Hudson Company and is illustrated herewith.

This car is over 65 ft. long and weighs about 65 tons. The engine and dynamo are located in a compartment at one end of the car and just behind it is a small baggage compartment. The remainder of the car is taken up by a smoking room and a regular passenger compartment, and there is also a motorman's compartment at the opposite end. It will seat 40 passengers, total, and is built on the lines of the standard Delaware and Hudson passenger coaches.

The gasoline engine used in this car was built by the Wolseley Tool and Motor Car Company, Ltd., Birmingham, England, and is said to be the most powerful gasoline unit ever constructed for this class of work. It develops 160 brake h.p. at a speed of 450 r.p.m. There are six horizontal opposed cylinders, three on each side, each 9 ins. in diameter and 10-in. stroke. The general appearance of this engine is shown in the interior view and cross section given herewith, the latter being taken from *Engineering* (London). It will be seen that the valves are mechanically operated from a cam-shaft, each chamber being fitted with two induction and two exhaust valves. These valves are steel forged of the mushroom type. There are two carburettors, one for each set of three cylinders, which consist of a jet set in the mixing chamber, and are fed by gravity from the float chamber. The valve to this mixing chamber is opened by the suction of the engine and is held closed at all other times. The valve controlling the proportions of fuel and air to the mixing chamber is on top of the carburettor. There are two feed chambers for each carburettor, one for gasoline and one for oil, so that either fuel may be used as desired. The air drawn into the carburettor is taken from the crank chamber, the idea being that in case any gas leaks by the piston rings into this closed chamber it will be removed in this manner. Gasoline is stored in steel tanks beneath the car and the exhaust passes through mufflers in the roof. The circulation water for cooling the cylinders is stored in the engine base and is cooled by radiating pipes located on top of the car. There is also a system of piping by means of which this hot circulating water can be used in heating the car. The lubrication is especially complete, being forced feed for all main bearings and pistons and a drip feed for all other working parts.

There has been much difficulty experienced in starting gasoline engines of this size and a very novel scheme has been introduced in this case for overcoming it. The engine is started by means of ordinary black powder cartridges containing sufficient powder to give the piston a pressure equal to about one-half the ordinary working pressure. These cartridges are inserted in a special block in the cylinder heads and are fired by a mechanism which is operated by the timing gear of the usual electric ignition. The first cartridge is exploded by hand and the others are automatically fired at the proper point. There is an indicator on the engine which shows the exact location of each piston in its cylinder and from this the starter can tell which cartridge to fire first. After the engine is started by cartridges in three of the cylinders it picks up its own charge and continues working on a low tension ignition line. There is a special set of lifters for opening the exhaust valves, so that any compressed air or gas already in the cylinders can be removed before firing the cartridges.

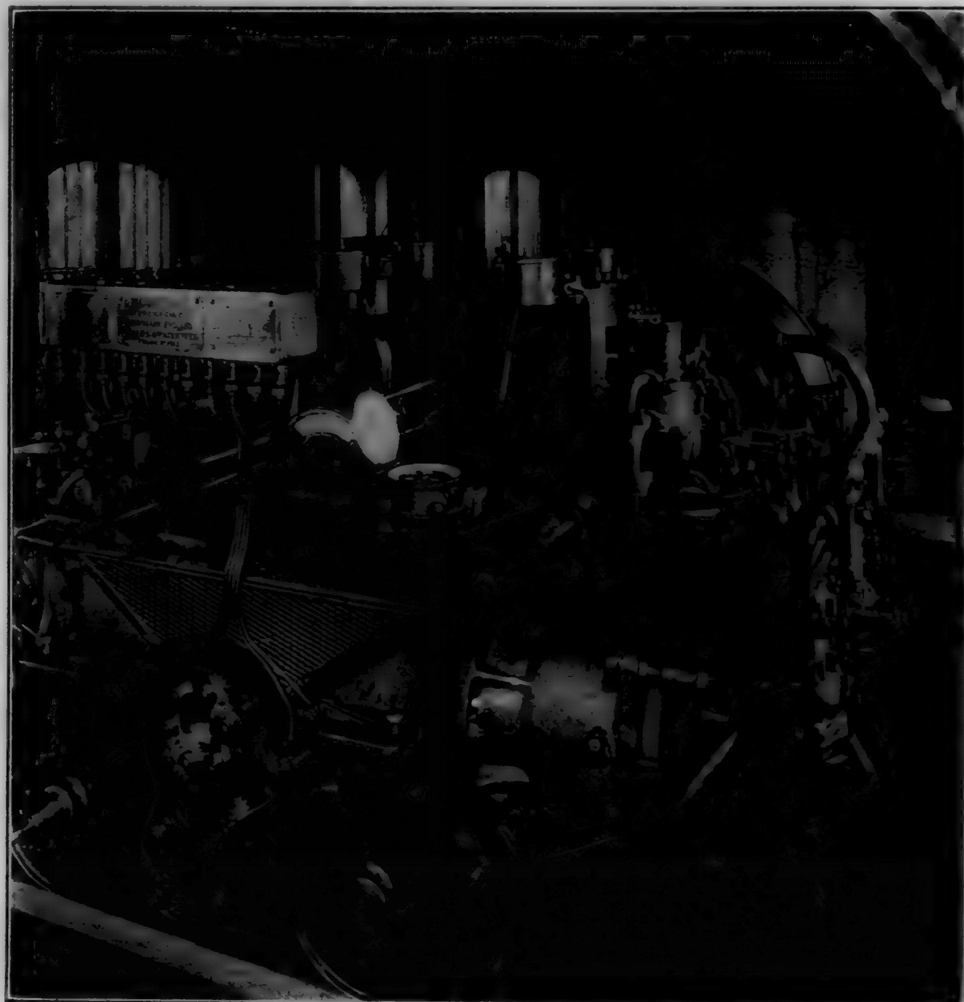
Two ignition systems are provided, a jump spark and a low tension system, the former obtaining its supply from the accumulators and intended primarily for use in case of emergency and the latter obtaining current from a small magneto driven from the engine shaft.

This engine is direct connected to a 120 k.w. General Electric generator, designed for 600 volts. This generator is provided with commutating poles which, in connection with the method of voltage control, permits a very flexible operating system. The special conditions under which this generator operates require a large current at low voltage to give the necessary torque at starting and makes the addition of commutating poles necessary. The generator, while retaining the characteristics of a shunt wound machine, is separately excited by a 5½ k.w. two-pole compound wound exciter working at 110

volts. This is located on top of the generator and is driven by a Morse silent chain. On the trucks there are two GE 69 railway motors, which are similar to those used on the Interborough Railway, New York.

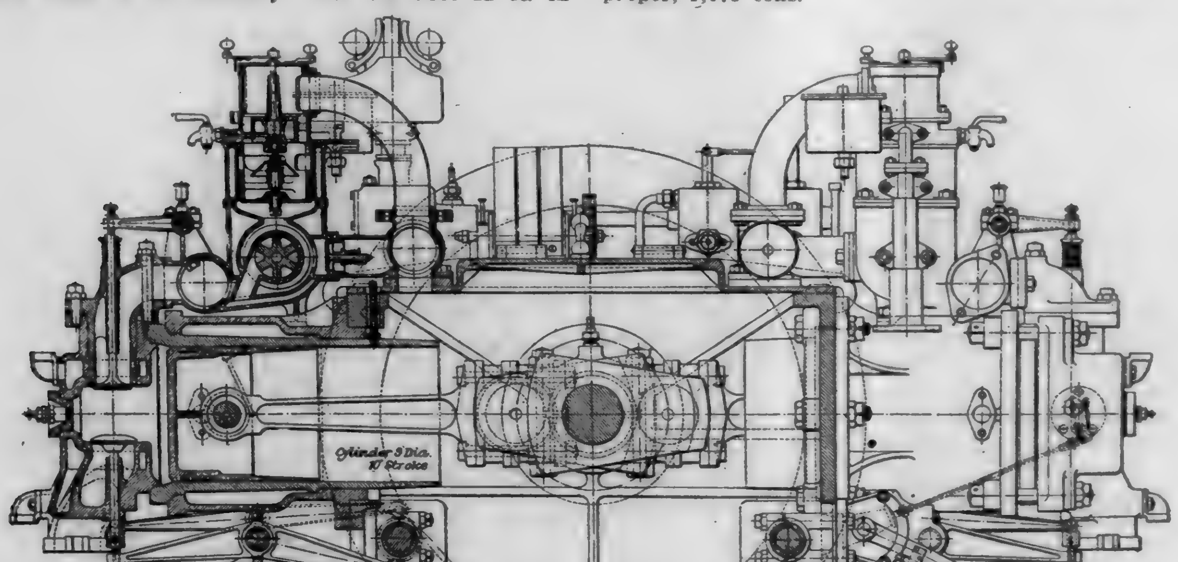
The voltage control speed regulation is used, or, in other words, the speed of the car is governed by varying the field strength of the generator. In this manner the speed of the engine remains constant. The controllers are semi-automatic and can be set for any predetermined maximum acceleration. The series parallel control with five positions of the handle is used.

The first trial run of this car took place on February 3, when a successful trip was made from Schenectady to Saratoga, N. Y., and return. While the car was not designed for especially high speed, the average running time was about 35 miles an hour and at several times it attained a speed of over 40 miles an hour. The running was particularly smooth, no vibration being noted and the acceleration was rapid and smooth.



WOLSELEY GASOLINE ENGINE—DELAWARE & HUDSON MOTOR CAR.

LARGE STEEL-CONCRETE STACK.—The largest and highest concrete chimney in the world has just been completed at the Butte Reduction Works, Butte, Mont. The inside diameter at both the top and bottom is 18 ft. and the height of the chimney is 333 ft. 4 ins. or 352 ft. 7 ins. above the surface. The foundation of the chimney is formed of slag poured in the molten state into a grey iron casing 100 ft. sq. The base is of Portland cement concrete 42½ ft. sq. and 8¼ ft. high. Metal was distributed both through the slag foundation and the concrete base and some of it projected up above the base and into the walls of the chimney. For the first 21 ft. in height the concrete walls of the chimney are 18 ins. thick. Above this the wall is a double shell, the outer one being 9 ins. thick and the inner one 5 ins. thick, with a 4-in. air space between. The concrete walls contain vertical and horizontal steel bars. The weight of the chimney is as follows: Slag foundation, 12,800 tons; concrete base, 1,000 tons; chimney proper, 1,475 tons.



CROSS-SECTION OF 160 H.P. WOLSELEY GASOLINE ENGINE.

GASOLINE ELECTRIC MOTOR CAR.

Delaware and Hudson Company.

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GASOLINE ELECTRIC MOTOR CAR—DELAWARE AND HUDSON COMPANY.

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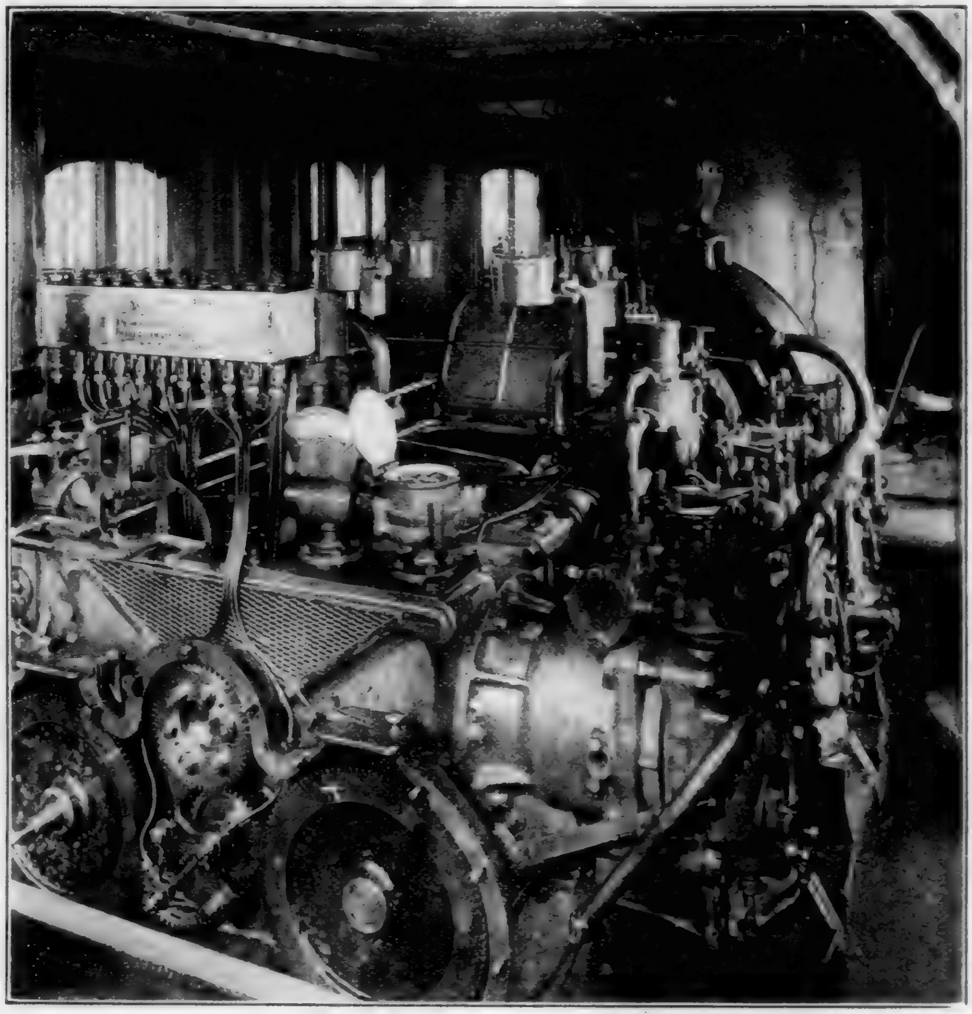

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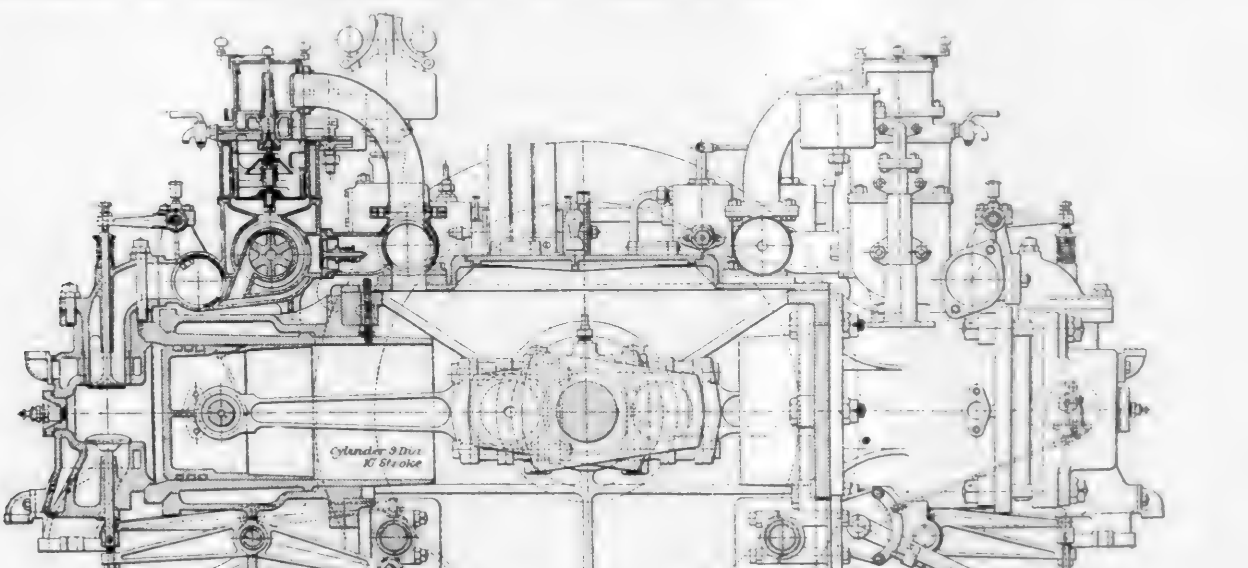


CROSS-SECTION OF 160 H.P. WOLSELEY GASOLINE ENGINE.

LOCOMOTIVE TESTS AND EXHIBITS OF THE PENNSYLVANIA SYSTEM AT ST. LOUIS.

A 727 page, standard size volume, containing a detailed account of the exhibits, together with the complete results from the locomotive tests made on the testing plant by the Pennsylvania System at the Louisiana Purchase Exposition, has been issued by the Pennsylvania Railroad Company.

This book forms a most valuable addition to locomotive literature, containing, as it does, the first complete and accurate results of the operation of modern locomotives under controllable conditions. Too much praise cannot be given to the railroad system, the exhibition management and the advisory committee for their efforts in this work.

The first chapter deals with the exhibits shown, other than the testing plant. It contains a description of those of the engineering department, which consisted of large models of the West Philadelphia terminal yards, the New York terminal station and the New York-Long Island tunnel; a full size section of the North and East River tunnels and a large assortment of maps, showing recent changes in the line. The exhibit of the voluntary relief and pension departments consisted of charts showing the growth and expansion of this work and copies of reports, regulations and other literature. The charts are reproduced in this book. The Pennsylvania Railroad department Y. M. C. A. exhibits of photographs, tables of membership, etc., is mentioned, and a brief note on the DeGlehn compound locomotive and the typical postal car is also given.

The remainder of the volume is given up to a description of the locomotive testing plant, the locomotives tested and the results obtained. The plant itself is most thoroughly illustrated and described, drawings showing the details of all important parts being included. A similar description of this plant and dynamometer was given in the AMERICAN ENGINEER AND RAILROAD JOURNAL in April, 1905, page 127.

Following the description of the plant several chapters are devoted to the method of forming the advisory committee, its members, the distribution of the operating force on the plant, the plan and scope of the tests and the calibration of the instruments used. This part of the book was issued in its original form as Bulletin No. 1 (AMERICAN ENGINEER AND RAILROAD JOURNAL, January, 1904, page 29).

The next chapter gives the methods of recording tests and considers all the matter given in Bulletin No. 3 (AMERICAN ENGINEER AND RAILROAD JOURNAL, 1904, pages 301, 365, 400), with a number of additions and explanatory notes. The several following chapters give in detail the methods of conducting the tests, the selection of locomotives and why they were selected, installation and preliminary operation of the plant and also an account of the interruptions and delays from various causes.

Then follows a chapter and its appendix for each locomotive tested, which includes a complete report of all observed and computed data, together with tables, computations made for arriving at results, general and detail drawings of the locomotives, typical diagrams at different speeds, typical indicator cards at different speeds and cut-offs and diagrams showing results of counterbalance and vibration tests where such were made.

The last two chapters in the book are given up to comparisons and conclusions, showing both by table and in diagrammatic form the comparisons of all interesting and important features between the different locomotives. These chapters contain the meat of the whole book, and the following extracts from them will give an idea of the valuable information which was shown by these tests and is included in this book.

BOILER PERFORMANCE.

Results show that when forced to a maximum power the large boilers delivered as much steam per unit area of heating surface as the small ones.

At maximum power the majority of the boilers tested delivered 12 or more lbs. of steam per square foot of heating surface per hour; two delivered more than 14 lbs. and the boiler of the Cole compound engine delivered 16.3 lbs., which is .47 boiler horse power per square foot of heating surface.

The relative advantage of large and small grates is not definitely settled, but the results are conclusive in proving that the furnace losses due to excess air are not greater with the large grate when properly fired than in the case of the small grate. The evaporative efficiency is generally maximum when the power delivered is least.

The results indicate that the percentage of moisture in steam from the locomotive boilers under average conditions is 1½ per cent.

It would appear that there is no special advantage in large firebox heating surface; probably the tube heating surface if ample will absorb the heat not taken up by the firebox.

It would appear that the heating surface of the Servé ribs is not equal to ordinary tube heating surface in capacity.

The temperature of the firebox under low rates of combustion is between 1,400 and 2,000 deg. F., and the maximum values at high rates is between 2,100 and 2,300 deg. F.

The smokebox temperature when worked at light power is not far from 500 deg. F., and has a maximum value when the boiler is forced of between 600 and 700 deg. F.

In general, it appears that the boilers for which the ratio of grate surface to heating surface is largest are those of the greatest capacity.

A brick arch will make possible higher firebox temperature and thus decrease the percentage of CO.

After a relation of .14 sq. ft. of air inlet per square foot of grate was reached no further decrease of draft occurred when the air inlets were increased, and when the air inlets were less than .11 sq. ft. per square foot of grate the draft necessary to supply air increased very rapidly.

In a number of tests the equivalent of evaporation per pound of coal was 12 lbs., and in only a few cases did it drop as low as 6 lbs.

ENGINE PERFORMANCE.

The indicated horse power of the modern simple freight locomotive tested may be as great as 1,000 or 1,100, and that of the modern compound passenger locomotive may exceed 1,600 h.p.

The maximum indicated horse power per square foot of grate surface lies for freight locomotives between 31.2 and 21.1, and for passenger locomotives between 33.5 and 28.1.

The average minimum steam consumption per I. H. P. for simple freight engines was 23.7; the consumption for maximum power was 23.8, and for conditions which were shown to be the least efficient 29.

The compound locomotives tested using saturated steam consumed from 18.6 to 27 lbs. per I. H. P. hour. The superheater engines gave a minimum consumption of 16.6 lbs. of superheated steam per hour.

In general, the steam consumption of simple locomotives decreased with increase of speed while that of the compound locomotives increased; thus it appears that the relative advantage to be derived from the use of the compound diminishes as the speed is increased. One of the tables shows that there would be no difference between the two at about 200 r.p.m.

Tests under a partially open throttle show that when the degree of throttling is slight the effect is not appreciable; when the throttling is more pronounced the performance is less satisfactory than when carrying the same load with a full throttle and a shorter cut-off.

PERFORMANCE OF THE LOCOMOTIVE AS A WHOLE.

All of the tests indicate the desirability of using locomotives with ample margin of power for the average work to be done, and no disadvantage is shown in operating locomotives at considerably less than their maximum capacity.

The percentage of the cylinder power which appears as a stress in the drawbar diminishes with increase of speed. At 40 r.p.m. the maximum is 94 and the minimum 77; at 280 r.p.m. the maximum is 87 and the minimum 62.

The loss of power between the cylinder and drawbar is

greatly affected by the character of the lubricant. It appears from the tests that the substitution of grease for oil upon axles and crank pins increases the machine friction from 75 to 100 per cent.

The coal consumption per dynamometer h.p. hour for the simple freight locomotive tested is at low speeds not less than 3.5 lbs. nor more than 4.5 lbs., the value varying with running conditions. At the highest speeds the coal consumption for the simple locomotives increased to more than 5 lbs.

The coal consumption per dynamometer h. p. hour for the compound freight locomotives tested is, for low speeds, between 2.0 and 3.7 lbs. The coal consumption per dynamometer h.p. hour for the four compound passenger locomotives tested varies from 2.2 to more than 5 lbs. per hour. In the case of all of these locomotives the consumption increases rapidly as the speed is increased.

A comparison of the performance of the compound freight locomotives with that of the simple freight locomotives is very favorable to the compounds. For a given amount of power at the drawbar the poorest compound shows a saving in coal over the best simple which will average above 10 per cent., while the best compound shows a saving over the poorest simple which is not far from 40 per cent. It should be remembered, however, that the conditions of the tests, which provide for the continuous operation of the locomotives at constant speed and load throughout the period conveyed by the observations are all favorable to the compound.

It is a fact of more than ordinary significance that a steam locomotive is capable of delivering a horse power at the drawbar upon the consumption of but a trifle more than 2 lbs. of coal per hour. This fact gives the locomotive high rank as a steam power plant.

Copies of this book may be obtained from D. S. Newhall, Purchasing Agent Pennsylvania Railroad Company, Broad St. Station, Philadelphia, at the very reasonable price of $5.00 per copy. This price does not, of course, begin to represent the cost of the book, and is made low so that the valuable information contained may be available to all who desire it.

The True Function of an Engineer.—"The dollar is the final term in almost every equation which arises in the practice of engineering in any or all of its branches, except qualifiedly as to military and naval engineering, where in some cases cost may be ignored. In other words, the true function of the engineer is, or should be, not only to determine how physical problems may be solved, but also how they may be solved most economically. For example, a railroad may have to be carried over a gorge or valley. Obviously it does not need an engineer to point out that this may be done by filling the chasm with earth, but only a bridge engineer is competent to determine whether it is cheaper to do this or to bridge it, and to design the bridge which will safely and most cheaply serve, the cost of which should be compared with that of an earth fill. Therefore, the engineer is by the nature of his vocation, an economist. His function is not only to design, but also so to design as to ensure the best economical results. He who designs an unsafe structure or an inoperative machine is a bad engineer; he who designs them so that they are safe and operative, but needlessly expensive, is a poor engineer, and, it may be remarked, usually earns poor pay; he who designs good work, which can be executed at fair cost, is a sound and usually a successful engineer; he who does the best work at lowest cost sooner or later stands at the top of his profession, and usually has the reward which this implies."—*Henry R. Towne at Purdue University.*

Water Softening.—The benefits to be derived from softening of bad boiler feed waters are now being appreciated by the railroads which have put in such plants. The absence of cracked firebox sheets, reduced flue leakages, shorter detention in the engine house and better steaming qualities are very noticeable on the engines using purified water.

COST OF LOCOMOTIVE SERVICE AS EFFECTED BY POOLING.

While pooling is known to have a marked effect upon the cost of various items of locomotive service, it has been difficult to secure figures which were strictly comparable illustrating its effect, and this journal has for a long time been seeking for information of this kind. Regretting that the name of the road cannot be given, the accompanying record is presented, having been prepared especially for our use.

The statements cover 20 locomotives in each case. The period of time for the record of locomotives not pooled is from December to March of one year, and the record of locomotives pooled is from December to March, inclusive, of the same locomotives during the following year.

A study of this record, as given in the table below, discloses some very interesting facts in connection with the increased costs of pooling. In comparing the two cases it will be seen that while the total mileage of the 20 engines not pooled decreased 7 per cent., the ton miles total decreased only about 2⅓ per cent., and this was largely in passenger service, the ton miles of freight service being almost the same in both cases. As a total this shows that it would require 44 engines not pooled to handle the same ton mileage as 43 engines pooled, and while the figures given show that by pooling the locomotives the object of more mileage per engine was accomplished to a slight degree, the matter of increased cost of maintenance in all respects increased at a very much larger ratio.

	Pooled.	Not Pooled.	Decreased.	Per Cent. Decreased
Mileage	2,552,392	2,375,235	177,157	6.95
Ton miles, passenger	138,167,604	125,198,342	12,969,262	9.4
Ton miles, freight...	585,501,026	581,629,881	3,871,145	.66
Ton miles, total.....	723,668,630	706,828,223	16,840,407	2.33
Total cost lub. oil...	$5,430.72	4,359.59	1,071.13	19.75
Cost, lubricating oil per 100 E. M....	$ .213	.184	.029	13.6
Cost, lubricating oil per 1,000 T. M...	$ .0075	.0062	.0013	17.4
Total tons of coal..	143,978	129,138	14,840	10.3
Lbs. of coal per E. M.	112.8	108.7	4.1	3.67
Lbs. of coal per 100 T. M........	39.79	36.54	3.25	8.15
Cost of repairs, total	$104,266.21	87,420.29	16,845.92	16.1
Cost of repairs per 100 E. M........	$4.08	3.68	.40	9.8
Cost of repairs per 1,000 T. M......	$ .14	.12	.02	14.2
Total cost of tools and supplies.....	$4,833.97	3,981.00	852.97	17.7
Cost of tools & supplies per 100 E. M.	$ .19	$ .17	$ .02	10.5
Cost of tools & supplies per 1,000 T. M............	$ .0067	.0056	.0011	16.4

The figures for the cost per 100 engine miles and per 1,000 ton miles puts this matter on a fair basis for comparison and it will be seen that the cost of lubricating oil per 1,000 ton miles decreased about 17½ per cent.; the pounds of coal used per 100 ton miles decreased over 8 per cent., the cost of repairs per 1,000 ton miles decreased about 14 per cent, and the cost of tools and supplies over 16 per cent.

These figures are interesting and show clearly that where it is possible to double crew it is most decidedly more economical to do so.

In the table the initials T. M. stand for ton miles and E. M. for engine miles.

Value of Special Chucks.—On quite a few castings which are to be finished we commonly add a flange or series of lugs to fasten it to a face plate. The metal in these lugs or flanges is paid for at a new metal price and goes back to the foundry at a scrap price, a material loss, of course. Instead of doing this over and over, perhaps a thousand times a year, get your shop inventor to contrive some sort of a permanent chuck which will hold the casting in some other way and will save this waste. A chuck costing $5 will perhaps save $100 a year. —*Mr. C. J. Crowley, Western Railway Club.*

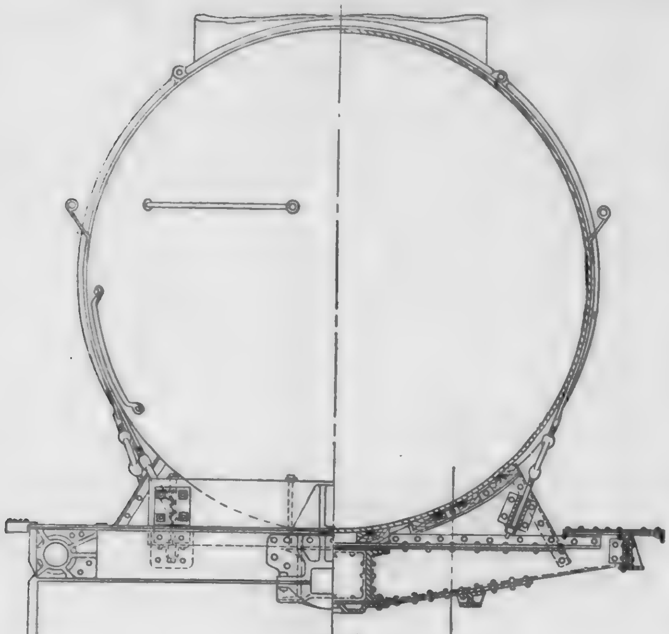


FIG. 1

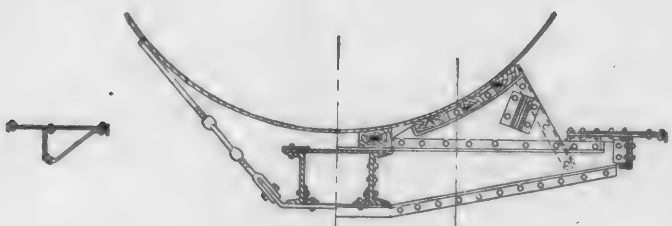


FIG. 2

PENNSYLVANIA TANK CAR PATENTS.

The Official Gazette of the United States Patent Office for February 1st, 1906, contains a notice of the dedication to the public, by the Pennsylvania Railroad Company, of an invention secured by United States Letters Patent No. 790,690, granted May 23, 1905, to William F. Kiesel, Jr., for improvements in the underframes of tank cars. The underframe, embodying these improvements, is of steel, and is strong, light and of simple construction, as may be seen by reference to the accompanying illustrations.

The center sills consist of heavy channels, which are continuous the full length of the car. These sills have a top cover plate extending between the wooden head blocks against which the ends of the tank rest. Between the body bolsters the sills are reinforced by angles riveted on the inside at the lower edge, as shown in Figs. 2 and 4. The side sills consist of light channels with the flanges turned inward. The function of the side sills is to form spacers and longitudinal braces for the ends of the body bolsters and cross bearers, and also to support the foot boards which extend along either side of the car. The end sills, channels with the flanges turned outward, are secured to the ends of the side and center sills by angle plates.

The body bolsters are formed of two pairs of vertical plates having flanges pressed on the inner, lower and outer edges. Riveted to the flanges at the lower edge is a cover plate which extends underneath the center sills, as shown in Figs. 1 and 7. The flanges on the inner edges of the bolster side plates are riveted to the center sills and those at the outer edges are riveted to the side sills. Extending almost the full width of the car above the centre sills and riveted on the inside of the bolster side plates are angles, to the lower flanges of which is riveted a cover plate. The triangular portions of the bolster side plates, which extend above these angles, are

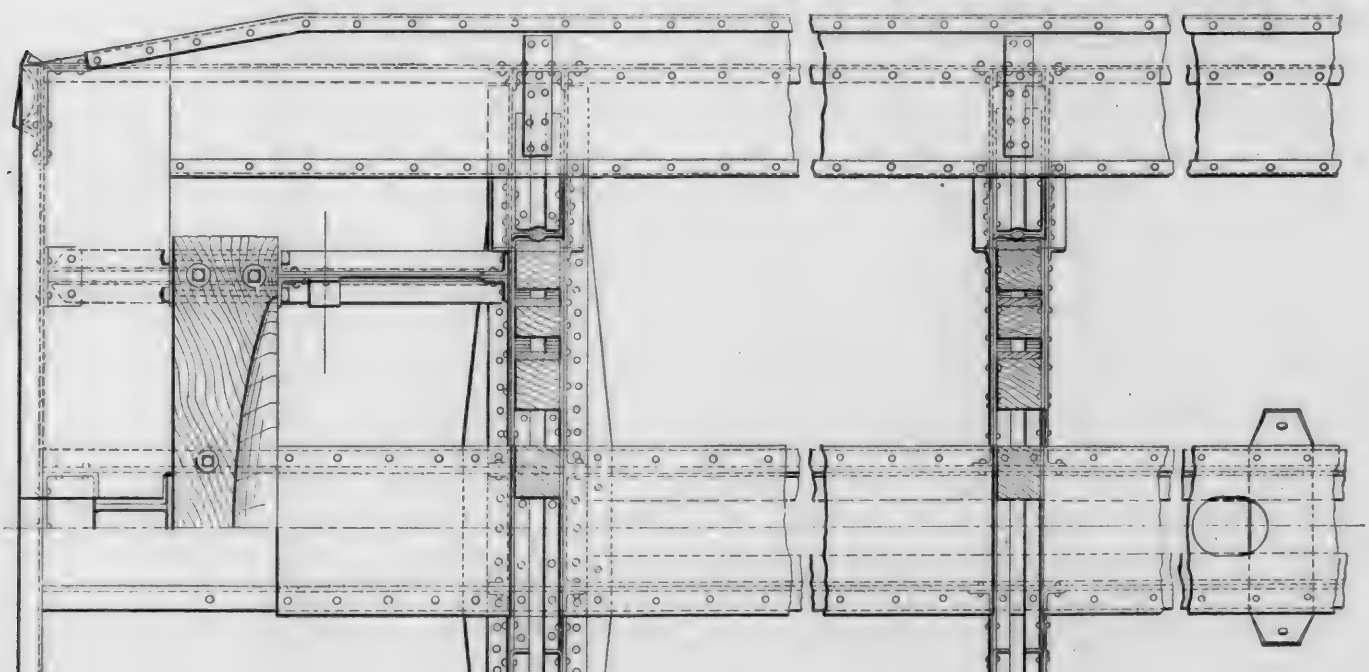


FIG. 3

STEEL UNDERFRAME FOR TANK CARS.

stiffened at the outer edge by light angles, as shown in Fig. 1. The inner or upper edge of these plates is curved to conform to the shape of the tank. On the inside of these curved edges (Figs. 1 and 7) are riveted angles on which are placed hard wood blocks upon which the tank rests. Between the center sills and on a line with the bolster side plates are flanged plates or diaphragms which are riveted both to the webs of the center sill channels and to the top and bottom bolster cover plates. To the bolster side plates and between them near the outer edge of the upper triangular portion, are riveted inclined eye-plates which receive the bolts to which the strap, which passes over the tank, is connected by turnbuckles.

The hard wood head blocks, which are shaped to conform to the end of the tank and prevent it from moving endwise, are bolted to the center sills and also to the angles which extend from the body bolster to the end sill and are riveted to the bottom of the vertical plate or brace, which

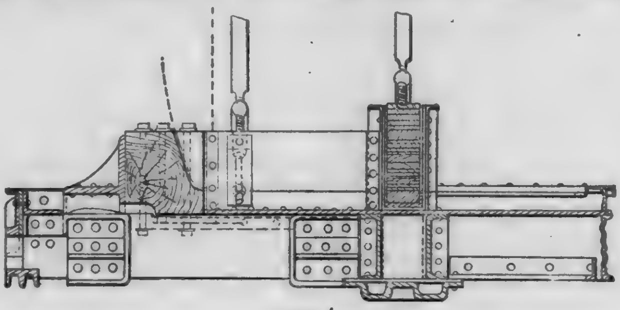


FIG. 4

FIG. 5

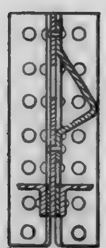


FIG. 6

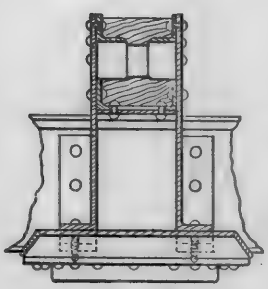


FIG. 7

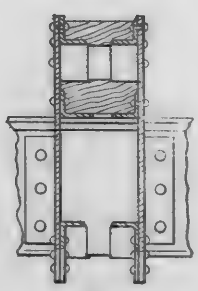


FIG. 8

extends between and is fastened to the body bolster and the head block, as shown in Fig. 4. Secured to a bracket (Fig. 6) on these vertical braces is a strap which passes around the end of the tank and holds it securely in place upon the head blocks. The head block is also braced by the heavy steel end casting which is riveted to the ends of the center sills and projects above them.

The foot plates, which extend along the sides of the car, are riveted to the top of the side sills, and between the bolsters and the cross bearers are supported at the inner edges by braces, as shown in the small figure at the left of Fig. 2. These foot plates are stiffened at the inner and outer edges by light angles.

Spaced equally between the body bolsters are two cross bearers, the construction of which is shown in Figs. 2, 3 and 8. The construction of these cross bearers is quite similar to that of the body bolsters except that the upper and lower cover plates are omitted and the lower edges are not flanged, but have angles riveted to them, which extend underneath the center sills and are riveted to the reinforcing angles on the sills. The diaphragms or flanged plates between the center sills are also omitted.

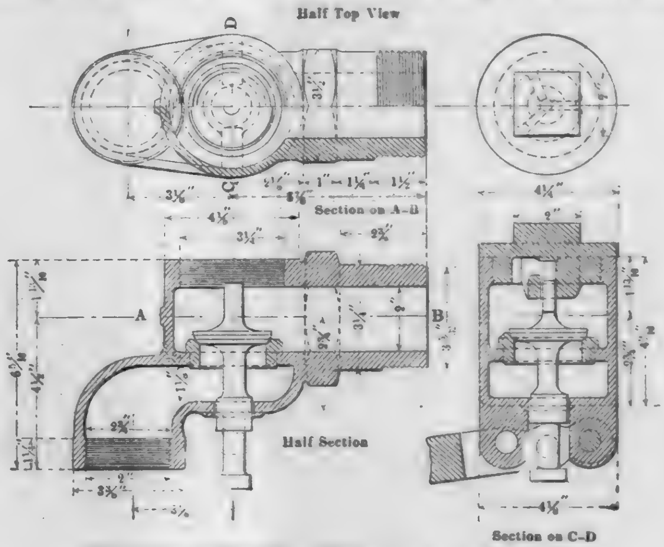
At the center of the underframe is a stirrup plate, shown in Figs. 3 and 5, to the upturned edges of which are attached eye-bolts which connect by turn-buckles with rods connected to a yoke which encircles the dome on the tank, thus preventing it from turning on the frame saddles.

STANDARD BLOW-OFF COCKS.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

By placing the regulations for the use of soda ash in the hands of a competent official of the department, this road has found it possible to make a great saving in boiler repairs and greatly improve locomotive service. In connection with this practice, the frequent blowing off of boilers and thorough washing out becomes important.

In the back head 11 washout plugs are provided, in the neighborhood of the throat three plugs, three more on each side at the crown sheet and four in the lower portion of the water legs at each side. In addition to these, the throat sheet



STANDARD BLOW-OFF COCKS—L. S. & M. S. RY.

has three plugs and the front flue sheet two. A surface blow-off is located in the back head, and the standard 2-in. blow-offs are placed in the water legs on each side, 10 or 12 ins. above the mud ring. This height is found desirable in order to save the blow-off valve seat from cutting from staybolt chips or scale. Mud settling below the blow-off cocks is removed through the washout plugs by frequent washing out. The construction of the blow-off cocks is shown in the engraving. They are operated by means of levers connected to handles extending up through the running boards. The drawing has been received from Mr. R. B. Kendig, mechanical engineer of the road.

CARS BUILT IN 1905.—Official returns from all of the car building plants in the United States and Canada, with the exception of one of the smaller builders, whose output we have estimated from our current records, show that 168,006 cars were built during the year 1905, including cars for use on subway and elevated railroads, but exclusive of street and interurban electric cars. These figures do not include cars built by railroads in their own shops, of which an exceptionally large number have been built this year. Of the above total, 165,455 are for freight service, and 2,551 are for passenger service, 162,701 are for domestic use, and 5,305 are for export. This is the largest car output in any one year that we have yet reported, and is considerably more than double the total output for last year, which was 62,950. The next largest output for any one year was in 1902, when a total of 162,547 cars were built.—*Railroad Gazette.*

IN THE RAILROAD SHOPS.

By A. S. Atkinson.

Shop kinks and devices for saving time, labor and power may be picked up occasionally in visits to the different railroad repair shops, but it is not always possible to adapt them entire to other places. Master mechanics, foremen and others frequently originate methods of saving time and money, which, while they are hardly valuable enough to patent, are worthy of imitation. The distribution of the different mechanical implements of a shop to save space and increase their efficiency is a matter that usually requires the technical training of designing engineers, but not infrequently a shop foreman can make suggestions that come from actual practical work that are of the utmost value. A great deal of the weakness of many designs for shop installation is due to the fact that the practical workers, the foremen, mechanics and operators, are not considered as factors of sufficient importance to consult. In too many cases the designing engineer considers the distribution of the different machines solely from the standpoint of economy of space and the cost of supplying them with power. The grouping of machines on one shaft or pulley so that they can be operated singly or together at a minimum cost of power is a good thing, but when they are arranged so the operators must waste considerable time in getting at the different machines the economy is not always so apparent.

For instance, in one railroad shop where modern machine tools are in use a combined vertical and horizontal spindle milling machine was installed near the center of the shop. This machine was up to date in construction, and represented the acme of modern invention in this direction. It was capable of doing a wide variety of work. Circular pieces could be machined with either the vertical or horizontal spindle. The machine was provided with spindles for face milling cutters, and by means of a detachable table almost any form of cutting could be done. The different cutters could be driven in unison or singly, and also at variable speed. The capacity of the machine was as important as its adaptability. In all respects this complex machine was the triumph of modern ingenuity. But it was a source of concern and irritation to the mechanics and operators. Not one, but half a dozen, swore at it repeatedly, and intimated that they wished the thing was out of the shop. And why? Not because it did not work well, and perform all that the manufacturers had promised, not because it did not work smoothly and accurately, or that the cutting was not satisfactory in every way. But because the designing engineer had sought to economize space in the installation to such an extent that operation was badly handicapped. There may have been an economy of space, and the machine did more work for the space it occupied than any other machine in the shop. But it was always worked at a disadvantage. The men were forced to cramp themselves to reach the different levers and wheels. They were continually compelled to work in positions that tried their nerves and temper. And it was all so unnecessary. It was merely a case of poor judgment on the part of those who located the machine. In this case there was no remedy except its removal. This was done, however, after it was clearly shown that, taking into consideration the loss of time and annoyance caused in operating it so disadvantageously, it would be economy to make the change. Too often in shop work the comfort of the mechanics and workmen is not considered, and yet it is an important factor that counts in the end. A little tabulation of records will show this.

In a railroad shop in the West, where exact records were kept to ascertain the relative efficiency of different machines, it was decided to make the attempt to secure some data concerning the relative efficiency of the operators. Where mechanics of a certain grade are all paid alike it is natural to suppose that their relative efficiency is approximately the same. But it is not. They differ greatly, far more than the machines themselves. One is not only a competent mechanic and good operator of a complicated lathe or cutting machine, but he seems to turn out more work than another with comparative ease. Efficiency is a second-nature to him. To another it is an acquired art, and a difficult one at that. He labors and sweats harder than the first, but he never accomplishes as much work. It is impossible to eliminate this human element from the modern shop, no matter how many improvements are made. But there is another point which careful records of work bring out. Why should a group of workmen of one shop show a higher efficiency, a greater productive output, and a greater amount of high-grade work than a similar group in another shop? The records of the output of the men in charge of drills, lathes, grinders, punching machines and riveting machines in the above mentioned shop showed a variation of 5 to 20 per cent. Some men seemed to outclass all the others, and on certain days their work ran much higher than others. There was no way to account for this other than that some workmen, like some machines, were superior and capable of greater and better grade work. But when the average of the output of the class was compared with the records of another shop where similar data were collected it was found that the latter showed an efficiency nearly 10 per cent. greater than the average of the former. What was the cause? An investigation followed. The men appeared no better, and, in fact, many of them were not as competent. The suggestion was then made that it was the difference in the convenient arrangement of the machinery and the greater comfort of the men in their work. Efforts were made to change this. The foreman sought to improve the ventilation of the shop, shifted some of the smaller machines so fewer steps were necessitated in going from them to the larger machines, and even the lights were changed. The result of this was apparent within a month. The record of output of work steadily increased, and at the end of the year the data collected showed that the difference between the two shops had been wiped out.

One of the greatest improvements made in recent years in railroad shops has been in the matter of lighting. Several of the largest shops have installed perfect electric lighting systems, and a number have adopted the mercury vapor lighting system. This is a distinct gain in the milling department, where nice adjustment of the cutting tools is essential to perfect work. The adjustment of these cutting tools so that there will not be a variation greater than one-hundredth of an inch requires expert skill and time, and where the light is poor much valuable time is lost. In one shop the location of a large engine lathe was such that a distinct shadow was cast upon the place where careful measurement was necessary to set the tools. The practice had been for the mechanic to get an assistant to hold a lighted candle while he made the necessary adjustment. The time of two men in this way wasted did not seem to strike the superintendent or foreman of the shop for some time. Then one of the mechanics grumbled and said he could do 20 per cent. more work if he had a decent light. A drop incandescent light was furnished him suspended on a flexible cord, and he could shove this in any part of the machine he wished to inspect. He proved his assertion a dozen times over that he could save money with a proper light.

Of course, in the drafting room good light is supplied, and a great deal of thought has been expended in order to furnish the draftsmen just the proper kind and degree of light; but too often in the machine and repair shop the light is indifferent. Rapid, skilful workmanship is consequently hampered. Careful record of shop work during a given period will prove this. But it probably needs no proving to-day, for the tendency is to develop perfect lighting systems in all modern shops. The effect of the light upon the minds of the workmen is not an imaginary factor. It can be easily shown that operators turn out more and better work where their surroundings are pleasant and well illuminated. Deep shadows are depressing, especially on dismal, cloudy days. Workmen who find their machines cast in perpetual shadow always give the poorest and slowest returns. Ventilation is likewise of the greatest value. Good ventilation is a matter for the architect

to consider, but in many shops which have been in use for many years makeshifts have been attempted to secure better ventilation. In one old railroad shop the superintendent had directed a carpenter to cut a dozen square holes through the foundation of the building on each side, and to construct boxes similar to those in use for a house furnace. A door controlled from the inside opened and closed the air boxes so that the admission of outside air could be regulated to suit the needs of the men. "That invention saves me several thousand dollars a year," proudly remarked the superintendent, pointing to the home-made ventilation system. "In the first place it gives the men pure air to breathe, and that makes them work better. I guess I get 10 per cent. more work out of them. In the next place, it saves their health. I have fewer men laid off with colds and sickness through the winter. It's a good investment."

The most satisfactory machine ever invented must fail if it is not properly set up and kept in good working order. This is a very trite remark, but it has an important bearing on shop work. Recently, in visiting a shop where several giant engine lathes were in operation, it was suggested that one of the lathes did not work true. "Probably not," was the answer of the foreman, "we've just had the millwrights set it up, and I never saw them do a proper job yet. The machine is set up in a primitive way. If it does not set on a true bed, the men drive wedges under the legs until it is true. They'll manage to get the machine on a level after much work, and then they consider their work done. But how long do you suppose a heavy piece of machinery is going to remain true set up in that way? Those chips will work loose within a week, and then your machine goes into all sorts of wobbly motions. If you are not careful something breaks, and a thousand or two dollars are wasted. You can't expect an engine lathe to bore true when it is not true on its legs. The only thing to do is to make the bed level, and have the machine stand level on its legs without any chips. Our own men generally do that. We have to true up the bed until there is absolutely no variation in the level."

A further examination showed that nearly 90 per cent. of the wooden beds for heavy machines in shops had more or less warp to them, and that chips and other material are used to true up the machines. One foreman said that it couldn't be helped. With an absolutely true floor or bed to begin with there would be a sag to it within a month, owing to the uneven pressure of the head and tail stock carriage. It was therefore necessary to either true up the machine every little while or make constant repairs to the floor. All of which is true, but it can be avoided in shops where it is possible to use concrete beds for the machines. In nearly all of the modern railroad shops concrete beds have been adopted for heavy machines, and this difficulty, which has caused so much trouble in the past, is partly avoided. In one old shop, however, where concrete beds are not used, the machines are trued up by the head mechanic in another way. When there is a sag on one end, the exact size of a chip needed is obtained by measurement. Then a flat piece of forging is made wide enough to cover the legs of the machine. Holes are drilled through, so that when placed in position the screws which hold the legs to the bed pass through the flat chips. In this way the machine cannot work loose, and it will not get out of level again until the wooden bed sags further.

Another method of preventing the uneven working of the heavy machine tools in an old railroad shop was to cut through the floor where the machine stood. A wooden box was then constructed down to the level of the ground, and the inside filled with good concrete, composed of three parts of sand and two of fine Portland cement. This gave a firm foundation to the machine when set up, and made it independent of the rest of the building. When in operation the machines would often cause the old building to shake and vibrate, but when all of the large ones were transferred to such separate, independent concrete beds the noise and vibration were reduced to a minimum. So well did this work that the superintendent declared the ideal way to construct shop foundations was to give a separate, independent floor to each machine. The flooring of the shop elsewhere may then be of brick, wood, stone or iron. The total elimination of vibration makes the machinery work smoother, and gives more certain results. Moreover, the repairing of each separate bed can be carried on more economically. Even for the lighter machinery this method has its advantages.

The crane equipment of any shop is its strongest or weakest point. Where the equipment is so carefully planned that every part of the shop can be reached with equal facility little need be said; but how many shops are thus equipped? In most of them there are nooks and corners that have been overlooked. In installing the overhead cranes it was not thought that any heavy lifting would be required for these neglected places, but in the expansion of the work new machines are installed, and the need of cranes which will reach every part is imperative. The ordinary portable cranes, with a lifting capacity up to 4,000 lbs., are thus necessary. Such cranes are small, compact and easily handled. They can be used in inaccessible corners and under low-ceiling parts of the shop. Home-made cranes of this character have been used in a number of shops for years, and the modern portable cranes really owe their origin to such primitive home-made cranes. Such a structure was built on a low-wheel truck some ten years ago in a railroad shop in the East. A forged L-shaped piece of iron, with a wide flat foot that screwed on the surface of the truck, was used for the lifting part of the crane. A chain running through a wheel on the end of the crane, and over a guide wheel at the break in the inverted L, and thence into a pulley wheel, carried the load. Heavy loads up to a ton and more could be lifted by this crane, and the truck could be pulled or shoved to any part of the building. The crane proved so serviceable that another of heavier carrying and lifting power was built, and to-day these two home-made affairs are in constant use, although factory-made portable cranes have been in the market for a number of years.

POWER PLANT ECONOMICS.—The following summary is presented in connection with a valuable paper on "Power Plant Economics" presented before the New York meeting of the American Institute of Electrical Engineers by Mr. Henry G. Stott.

1. The present type of steam-power plant can be improved in efficiency about 25 per cent. by the use of more scientific methods in the boiler room, by the use of superheat, and by running the present types of reciprocating engines high pressure, and adding a steam turbine in the exhaust between the engine and the condenser. At the same time the output of the plant can be increased to double its present capacity at a comparatively small cost for turbines and boilers.

2. The steam-turbine plant has an inherent economy 20 per cent. better than the best type of reciprocating engine plant, not so much due to its higher thermal efficiency as to a variety of causes.

3. An internal combustion engine plant in combination with a steam-turbine plant offers the most attractive proposition for efficiency and reliability to-day, with the possibility of producing the kilowatt-hour for less than one-half its present cost.

LOCOMOTIVE BOILER EXPLOSIONS.—According to *The Locomotive*, the quarterly publication of the Hartford Steam Boiler Inspection and Insurance Company, during the first six months of the year 1905 there were 33 explosions of locomotive boilers in the United States and Mexico. Three of these belonged to private companies and two more were the result of collisions. In the remaining 28 accidents there were 38 persons killed and 40 seriously injured.

PATTERNS FOR RAILROAD SHOPS.—It is a patent fact that patterns for railroad shop use are not skinned to the limit demanded by manufacturing concerns whose chiefs are generally principal shareholders in all profits.—*Mr. C. J. Crowley, Western Railway Club.*

SIMPLE CONSOLIDATION LOCOMOTIVE WITH WALSCHAERT VALVE GEAR.

BOSTON & MAINE RAILROAD.

The American Locomotive Company has recently delivered to the Boston & Maine Railroad an order of six consolidation locomotives equipped with Walschaert valve gear, one of which is illustrated herewith.

These engines are very similar to a large order previously supplied to that road which were fitted with the Stephenson link motion, and the two different designs are now being operated in the same service over the Fitchburg division between Boston, Mass., and Rotterdam, N. Y. Although they have not been in service long enough to obtain any comparative figures on operation or cost of repairs, Mr. Henry Bartlett, superintendent of motive power, states that this valve gear has developed a most favorable impression on all concerned, and that it is the general impression that the engines equipped with it will handle in the neighborhood of 50

CONSOLIDATION LOCOMOTIVE WITH WALSCHAERT VALVE GEAR—BOSTON & MAINE RAILROAD.

more tons than similar engines with the Stephenson gear. The present indications are that the roundhouse work promises to be much easier on these engines than on the others. In speaking on the subject, Mr. Bartlett states that he believes there has been no mistake made in applying the Walschaert gear, saying that, "the reduction of weight by the use of the Walschaert gear, the use of the single instead of the double eccentric, the readiness with which the motion work can be inspected and repaired, and last, but not least, the existence of constant lead, are features which readily commend this type of valve gear, and which, I believe, are going to make it so satisfactory that we shall see it applied to almost everything before many years."

A considerable change has been made in the cylinders of these locomotives for the purpose of obtaining a simple arrangement of the Walschaert valve gear in that the valve chamber is placed above with its center 4 inches outside the center of the cylinder. This permits the valve stem to connect direct to the combination lever extending up from the cross head connection. The bracket holding the link is fastened to the guide yoke, which is extended for this purpose. This arrangement gives the simplest and most direct design of Walschaert valve gear which we have seen.

In other respects the locomotive contains no particularly new features, being built on lines which are common to engines of this class and weight constructed by this company.

The general dimensions, ratios and weights are as follows:

2—8—0 TYPE SIMPLE LOCOMOTIVE, WITH WALSCHAERT VALVE GEAR—BOSTON & MAINE RAILROAD.

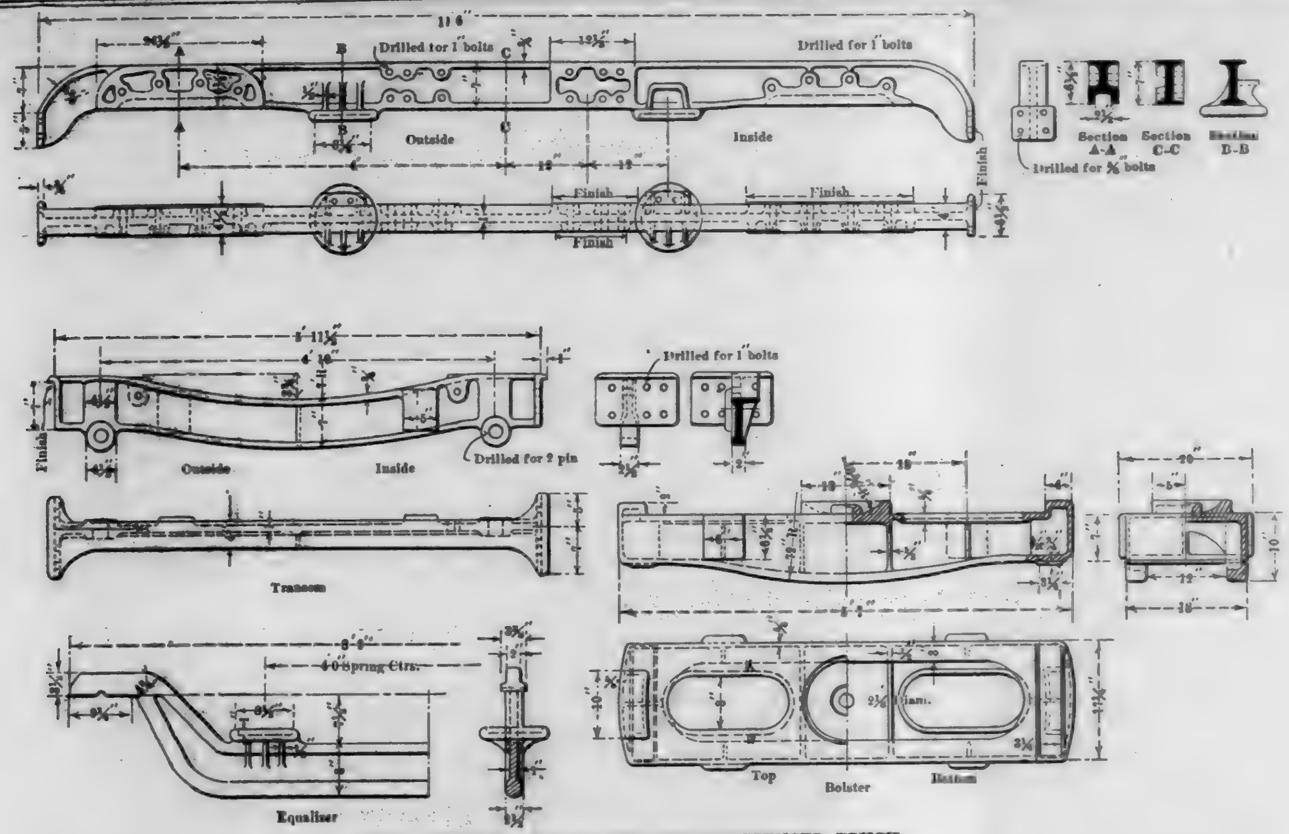
GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Freight.
Fuel	Bituminous coal.
Tractive power	33,400 lbs.
Weight in working order	170,000 lbs.
Weight on drivers	148,000 lbs.
Weight on leading truck	22,000 lbs.
Weight of engine and tender in working order	277,300 lbs.
Wheel base, driving	17 ft.
Wheel base, total	25 ft. 6 ins.
Wheel base, engine and tender	53 ft. 9⅜ ins.
RATIOS.	
Tractive weight ÷ tractive effort	4.43
Tractive effort x diam. drivers ÷ heating surface	712
Heating surface ÷ grate area	61.5
Total weight ÷ tractive effort	5.1
CYLINDERS.	
Diameter and stroke	20 by 30 ins.
Piston rod, diameter	3½ ins.
VALVES.	
Kind	Piston
Greatest Travel	5½ ins.
Outside lap	1 in.
Inside clearance	0 in.
Lead in full gear	3-16 in.
WHEELS.	
Driving, diameter over tires	61 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	9x11 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	6 by 10 ins.
BOILER.	
Working pressure	200 lbs.
Outside diameter of first ring	66 5-16 ins.
Firebox, length and width	65¼x102⅝ ins.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	3½, 4, 4½, 5½ ins.
Tubes, number and outside diameter	326 2 in.
Tubes, length	16 ft.
Heating surface, tubes	2716.87 sq. ft.
Heating surface, firebox	144.2 sq. ft.
Heating surface, total	2861.1 sq. ft.
Grate area	46.5 sq. ft.
Smokestack, diameter	16 ins.
Smokestack, height above rail	14 ft. 4⅝ ins.
TENDER.	
Wheels, diameter	33 ins.
Journals, diameter and length	5 by 9 ins.
Water capacity	5,000 gals.
Coal capacity	10 tons

CAST STEEL PASSENGER TRUCK.

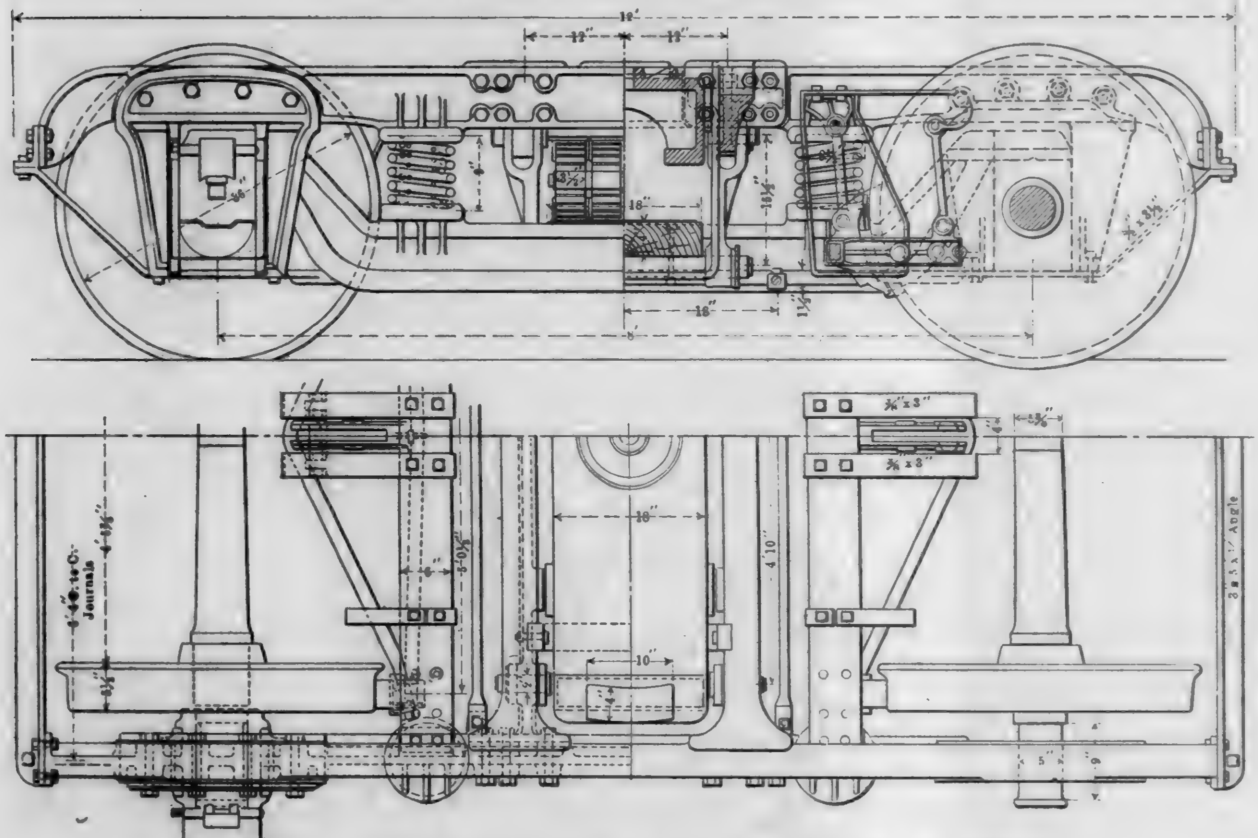
The Big Four has sixteen cast steel passenger trucks in service, four of which have been running about eighteen months, and their performance during that time has been satisfactory in every respect. The truck is designed to take the place of the 6-wheel trucks commonly used under baggage or express cars 60 ft. or more in length. By its adoption it has been possible to save in weight about 9,500 lbs. per car, as compared with the 6-wheel truck, and to reduce the cost about $275 per car. In addition, the friction of two pairs of wheels under each car is done away with, and this affords a considerable advantage in making time with high-speed trains, and is also a source of economy as regards the fuel pile.

With the exception of the wooden spring plank, all of the important members are of cast steel. The general appearance of the truck differs very little from the ordinary type; 5 x 9 in. journals are used and it weighs 13,000 lbs. The center plate and side bearings are cast integral with the bolster, which is of a channel trough section, open at the bottom; is 7 in. deep at the ends, 10 in. deep at the center and is 18 in. wide. The rib along the bottom of the sides is increased from ¾ of an inch thickness at the ends to 1½ in. at the center. The wheel piece is made in one casting 11 ft. 6 in. long, and is of I section between the pedestals; it is 5 in wide, 7 in. deep and the web is 1 in. thick. The equalizer spring caps are cast on the bottom and are strengthened by three ½ in. ribs on the outside and two on the inside.

The transoms are of an inverted L shape, are 7 in. deep and are depressed 3¾ in. at the center. Bosses, 5 x 6 in., cast on the inside act as bolster chafing plates; at the ends a flange



CAST STEEL DETAILS OF BIG FOUR PASSENGER TRUCK.



CAST STEEL PASSENGER TRUCK—CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RY.

is formed, 7 in. deep and 12 in. wide, with a lip along the top edge which projects over the wheel piece. This gives an ample bearing for the joint between the transom and the wheel piece, and the projecting lip assists the bolts in taking the downward shear. The equalizer bars are of a dumb-bell section, are 2½ in. wide and 8 in. deep. The equalizer spring seats are cast on them in much the same way as on the wheel piece. The end pieces of the frame are 3 x 5 angles.

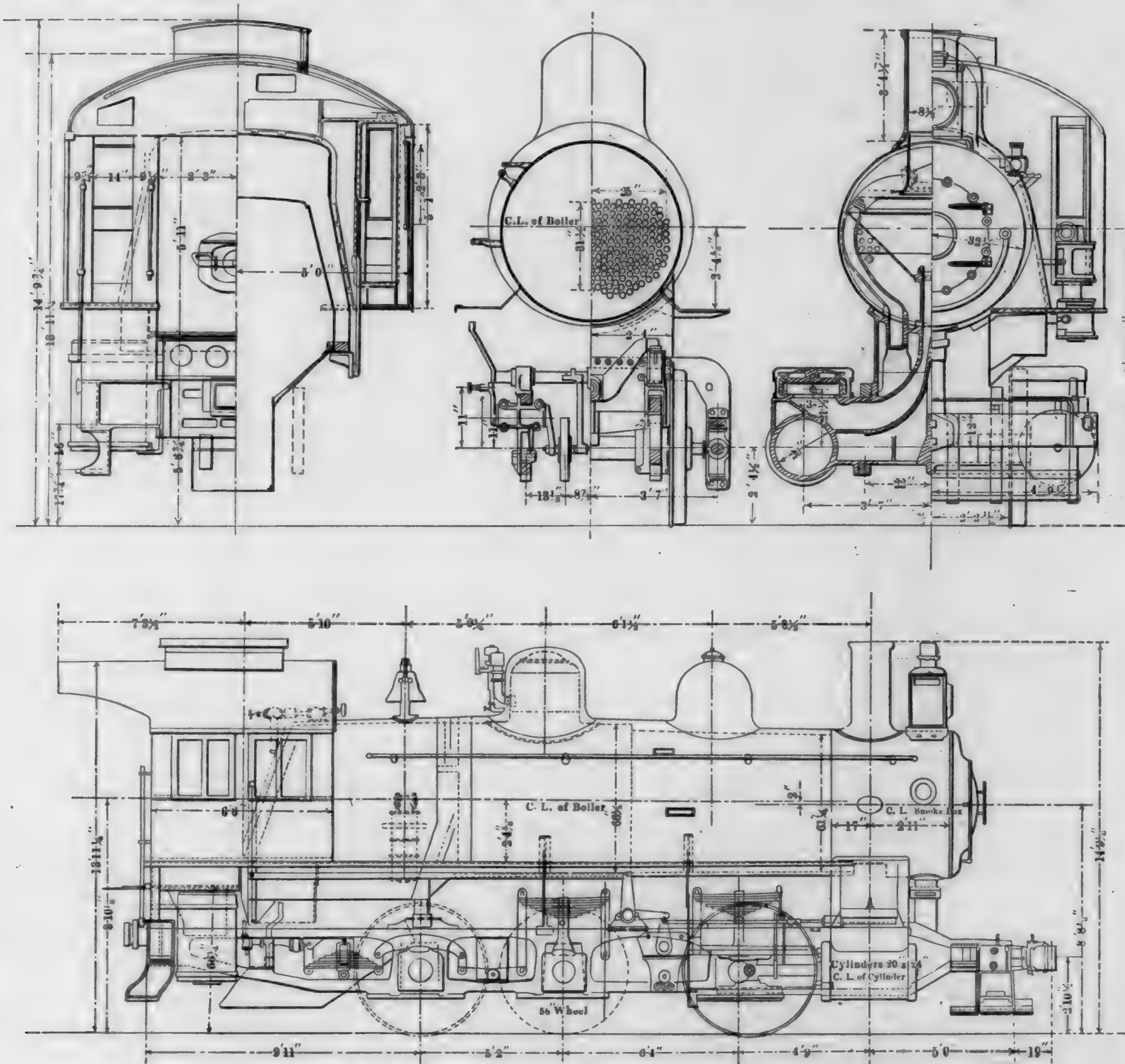
The brakes are inside-hung, and all of the brake rigging is hung from two 6-in. channels, placed with the flanges down. These channels are just outside of the transoms, and are attached at the ends to lugs cast on the inside of the wheel pieces. The wooden spring plank is used to deaden the metallic sound of the truck and to absorb the small vibrations set up in such a rigid construction. Two 1-in. bottom cross ties connect the bottom tie rods and strengthen the truck in a transverse direction. No rivets are used in the construction of the truck, but all of the connections are machined and bolted; this makes it possible to easily and quickly dismantle the truck for repairs. We are indebted to Mr. William Garstang, superintendent of motive power of the Big Four, for information and drawings.

SWITCHING LOCOMOTIVE.

PENNSYLVANIA RAILROAD.

In this journal in October of 1904, page 384, the Class B—6 heavy switching locomotive of the Pennsylvania Railroad was illustrated. As indicated in the accompanying list of dimensions this is a heavy locomotive with six driving wheels. It was designed to handle trains of the same weight as those hauled by the heaviest road freight locomotives, and was built for use in large yards and in loading car floats.

For general service a new design of the six-wheel type, designated as B—8, has been brought out for service where a large 6-wheel switcher is needed. The accompanying engravings show a side elevation and three sections, and the table shows the leading dimensions of both of the classes referred to. It will be noted that Class B—8 has D valves and a short firebox, but that otherwise the design, except as to heating surface and weight and other features depending upon and affecting them, very closely resembles the earlier Class B—6.



CLASS B-8 SWITCHING LOCOMOTIVE—PENNSYLVANIA RAILROAD.

SWITCHING LOCOMOTIVES—PENNSYLVANIA RAILROAD.

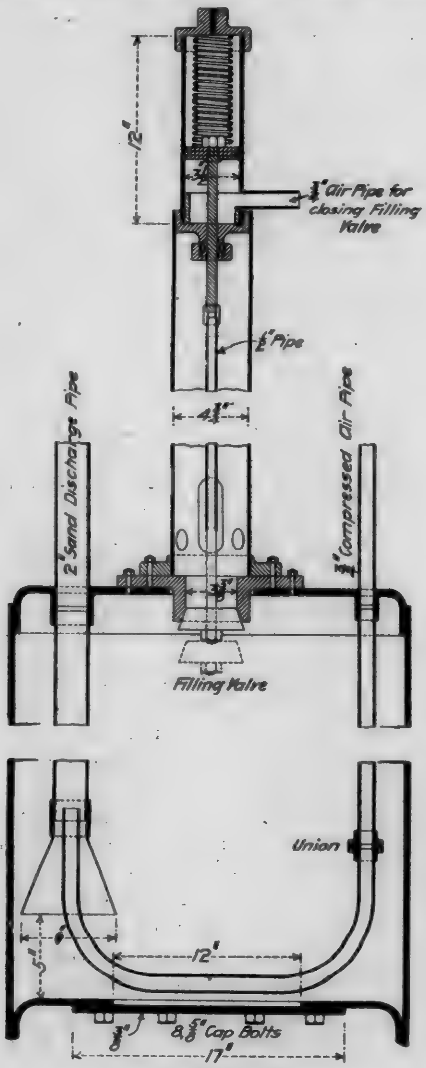
Class	B—6	B—8
No. of pairs driving wheels	3	3
Diam. of driving wheels	56 in.	56 in.
Size of driving axle journals	9½ in.x9 in. D x 12 in. L	9½ in x9 in. D x 12 in. L
Length of driving wheel base	11 ft. 6 in.	11 ft. 6 in.
Total wheel base of engine	11 ft. 6 in.	11 ft. 6 in.
Total wheel base of eng. and tendr.	48 ft. 3¾ in.	46 ft. 6¼ in.
Spread of cylinders	86 in.	86 in.
Size of cylinders	22x24 in.	20x24 in.
Steam ports	10 in. Piston V-2 in. wide	1¼ in.x15½ in.
Exhaust ports		2½ in.x15½ in.
Travel of valve	5 in	5 in.
Lap of valve	¾ in.	¾ in.
Type of boiler	Belpaire, sloping top	Belpaire, sloping top
Min internal diam. boiler	67¼ in.	60 in.
Number of tubes	325	247
Outside diam. of tubes	2 in.	2 in.
Length of tubes bet. tube sheets	166¼ in.	163½ in.
Fire area through tubes, sq. ft.	5.39	4.13
Size of firebox (inside)	66x90 in.	66x69 in.
Fire grate area, sq. ft.	41.25	31.62
Ext. heat'g surface of tubes, sq. ft.	2343.00	1762.1
Heating surface of firebox, sq. ft.	152.10	106.1
T'tl heat'g surface of boiler, sq. ft.	2495.10	1868 2
Steam pressure per sq. in., lbs.	205	205
No. of wheels under tender	8	8
Diam. of wheels under tender	33 in.	33 in.
Size of tender truck axle journals	5½ in.x10 in.	5½ in.x10 in.
Weight of engine empty, lbs.	146,000	128,900
Weight on first pair drivers, lbs.	60,000	45,900
Weight on second pair drivers, lbs.	59,500	52,600
Weight on third pair drivers, lbs.	50,500	45,600
Wt. of engine in work'g order, lbs.	170,000	144,100
Weight of tender loaded, lbs.	132,500	....
Ratio of heating surface to grate surface	60.4	59.1
Ratio of external flue heating surface to firebox heating surface	15.4	16.6

Tractive power per lb. of M.E pressure	207.4	171.4
Tractive power with M.E. pressure equal to 4/5 of boiler pressure	34,020	28,114

SAND HOUSE—SOUTHERN RAILWAY.

The Southern Railway has a convenient labor saving sandhouse arrangement at Knoxville, Tenn., which has been in use several years. From Mr. J. B. Michael, master mechanic at that point, we have received drawings showing the house and the sand elevating appliances.

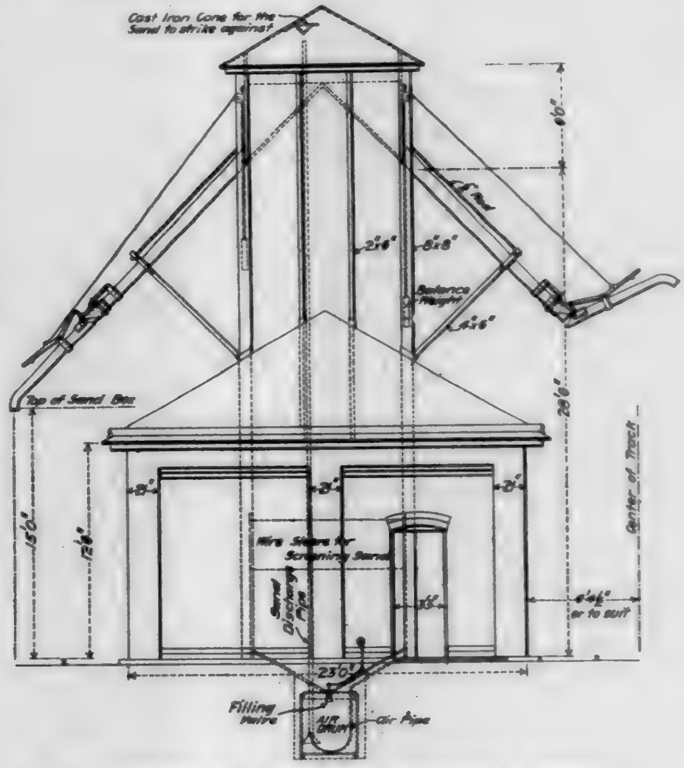
Sand is delivered upon the floor of the sand house and is shoveled upon the heaters. From these the dry sand is thrown upon a screen, through which it falls into a hopper, the top of which is level with the floor, and this hopper discharges into the top of an underground cylinder, which is an old main reservoir from a locomotive. The dry sand flows into this reservoir through the filling valve. When the cylinder is filled, air is admitted through the ¾-in. pipe, which opens under the funnel, and an air jet blows the sand to the top of the storage tower, from which it is discharged into the sand boxes of the locomotives through the spouts. The valve which admits the air pressure to the jet also admits the same pressure to the



SAND ELEVATOR.

cylinder, which closes the filling valve, thus cutting off the escape of sand at the top of the cylinder.

The sand house at Knoxville is 30 ft. 2 ins. by 21 ft. 2 ins., and 12 ft. 6 ins. high at the eaves. It is built of brick, with walls 17 ins. thick, and encloses four sand-drying stoves and a dry sand bin 8 ft. 7½ ins. square, which opens into the cylinder below. The overhead storage bins for dry sand are supported upon 8-in. by 8-in. posts, with a roof over the bins. The roof of the sand house is of slate. The accompanying engravings show the arrangement of the sand house and the manner of its operation. The sand elevator and method of automatically closing the inlet valve at the top of the sand reservoir is similar to that used at the Collinwood roundhouse of the Lake Shore & Michigan Southern Railway. (See AMERICAN ENGINEER, January, 1902, page 9.) Mr. Michael says that the sand cut out the piping very rapidly, and that it was found necessary to replace the delivery pipe with hose, and that the only material found to resist the wearing action of the sand in the valve is rubber.



ARRANGEMENT OF SAND HOUSE—SOUTHERN RAILWAY.

About 60 engines are supplied with sand at this point in 24 hours. One man is employed days and another nights. These men dry the sand, operate the sand plant and supply the engines after they are placed by the "hostlers." By the old method the sand was dried, as now, by stoves, and the dry sand was carried in buckets by two sand-house men and the "hostler," three men in all.

HISTORIC LOCOMOTIVE FOR PURDUE.—The latest addition to the collection of historic locomotives, and the sixth to take its place in the Purdue University Museum, is an 8-wheel connected tank locomotive named "Reuben Wells." This engine was built in 1866 by what was then the Jeffersonville, Madison & Indianapolis Railway for use on an incline which had a grade of 310 ft. to the mile and on which rack locomotives had been used. It was designed by Mr. Reuben Wells, then master mechanic of the railroad, who is now general manager of the Rogers Locomotive Works, for the purpose of supplanting the rack engines on this steep grade. The original engine had five drivers on a side, 20 x 24 in. cylinders and carried the feed water in two long cylindrical tanks below the running boards. The coal space was on an extension of the main frames so that the total weight of coal and water all came on the drivers and gave a weight in working order of 112,000 lbs. The engine operated for a long time in that condition, but was at a comparatively recent date shortened up so that at present it has but four drivers on a side, a smaller coal space, shorter cylindrical tanks and has had a saddle tank added on the boiler.

Labor cost items are generally less than material cost items, therefore it behooves every man in authority in these matters to watch his rough material.—*Mr. C. J. Crowley, Western Railway Club.*

(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE.

J. S. BONSALL,
Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT, E. A. AVERILL, } Editors.

MARCH, 1906.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union. Remit by Express Money Order, Draft or Post Office Order. Subscription for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn St., Chicago, Ill. Damrell & Upham, 283 Washington St., Boston, Mass. Philip Roeder, 307 North Fourth St., St. Louis, Mo. R. S. Davis & Co., 346 Fifth Ave., Pittsburgh, Pa. Century News Co., 6 Third St. S., Minneapolis, Minn. W. Dawson & Sons, Ltd., Cannon St., Bream's Buildings London, E. C., England.*

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

For years it has been our custom to keep on file the names of applicants, or men eligible for various positions. The demand recently has been so great that the list of draftsmen has been entirely depleted and we have been unable to furnish names in reply to twenty or twenty-five requests which have been received during the past month. This is a good indication of the remarkable period of prosperity which the business concerns of this country are enjoying at the present time.

In the rather general movement towards improved educational methods for railroad employees models may be made to play an important part. One of the leading roads has introduced progressive examinations for engineers and firemen, and has fitted up a number of models, by aid of which valve motion, various types of valves and the construction of compound locomotives may be studied. Many locomotive engineers and firemen have run under the guidance of railroad signals, both interlocking and block, for years without knowing more about the signals than that they indicate that trains may proceed or may not proceed. Models of signal apparatus need not be expensive, and they would form a valuable adjunct to educational equipment. If the men who are governed by signals could understand more about the operation of the signals and the reasons and rules governing their use they would doubtless be materially aided in their work. Some of the English roads make a practice of instructing engine men in the use of signals by the aid of models, and the practice has much to recommend it.

There is an interesting problem in engine-house construction for some one to solve. In warm or moderate climates it is relatively easy to know what to do, but where winters are severe, the engine-house question is still unsolved. The apparently necessary factors are proper heating and ventilation, a covered turntable and a house which will not be too expensive. Satisfactory heating in cold weather renders it desirable to avoid the multiplication of doors of the usual roundhouse, and this has led to the construction of rectangular engine houses, with internal transfer tables. A turntable or Y track is necessary with this plan, which, however, seems to be satisfactory as far as the building itself is concerned. At a busy terminal a rectangular house may take up more room than a circular house, because of the necessity for a turntable. A combination of a turntable and a transfer table in the same piece of machinery seems too complicated and too expensive to be acceptable. An engine house with a 100-foot turntable is expensive to build. It is possible that the Echelon engine house, suggested by Mr. J. J. Turner, of the Pennsylvania Lines, may provide a way out of this difficulty.

THE PENNSYLVANIA LOCOMOTIVE TESTS.

The publication of the results of the locomotive tests made on its testing plant at St. Louis by the Pennsylvania System, the conclusions of which are given in this issue, is an event of more than passing interest and importance. For the first time we have reliable information on the performance of modern locomotives, and have it arranged in such form as to be of practical benefit. While it is to be regretted that the original program of twelve engines could not have been carried out, as that would have included some simple passenger locomotives of the types in the most general use, still a group of eight, four passenger and four freight, which included six different types of compounding, both wide and narrow fireboxes, a superheater and wide limits of boiler ratios, all tested under exactly similar conditions, gives us figures which will be of great value in future design.

MECHANICAL STOKERS.

Locomotive improvements, which are really improvements, come slowly but the sluggishness of the locomotive stoker, in view of the imperative need, is incomprehensible. In recent years there never has been a want so definite and so well understood as that of means to put coal into a locomotive fire box without requiring tremendous human exertion to accomplish the task. If any one needs an explicit statement on this subject let them refer to the third paragraph of Mr. Garstang's remarks before the Master Mechanics' Association last June, which appeared on page 251 of the July number of this journal as follows:

"Ten years ago the most of us thought the maximum size of locomotives had been reached, when a spurt followed and the locomotive grew rapidly. Has the limit yet been reached? The engine having grown to such proportions in the past ten years, it is pertinent to ask, has the fireman also grown in that time? Experience says "No." An engine with 50 sq. ft. of grate surface, burning 200 lbs. per hour per square foot, will consume 5 tons per hour, and if you get a fireman with sufficient physical endurance to handle 5 tons of coal per hour on an engine scheduled 45 (or 50) miles per hour, as they are to-day, he will very likely fall below the requisite in brain power, and, of course, be an inefficient fireman. This we all know from experience. So it seems our engines have passed the limit of human endurance in the matter of efficient firing."

It would seem that nothing stronger than this can be needed to lead to immediate development of a stoker on a large scale to meet the conditions mentioned. The closing remarks by Mr. Garstang are also worth quoting, as they show his opinion after a wider experience with automatic stokers than any one else has had. His opinion is as follows:

"It is my opinion that the mechanical stoker for locomotives has come to stay, first because it is practical and efficient. Second, we believe by the adoption of the mechanical stoker the railway companies will be enabled to use a cheaper grade of coal than could be used in hand firing, resulting in a great reduction in their fuel bills. It will relieve the firemen of

some of his most arduous labor and give him greater opportunity to observe signals while on duty, and he will arrive at the end of his run in condition to improve his chances by studying for promotion to the position of engineer. The position of fireman on an oil burning locomotive is really attractive, and if the stoker is properly developed his position will be very, very nearly as comfortable with coal as fuel."

RECORD MAKING.

Record making is, in many respects, a good thing for the railroads. The personal records made by officials called in to do certain things, to accomplish certain results in the way of improvements enables the bookkeepers to show very remarkable results, but this making of records has another side which is, perhaps, not fully appreciated. The sort of record which a railroad needs is that which requires years in the making; it is one which, instead of showing results in one or two specific directions, permeates the whole, and for that reason does not appear on the surface as promptly as the record which is generally most talked about.

Record making on a railroad is somewhat analogous to the manipulation of a large billet of steel in the manufacture of a gun, a shaft, or a rail. Heavy pressure applied superficially will, in a small number of passes, produce a result which is sufficiently attractive in appearance, and is brought out in such a short time as to lead a superficial observer to say that at last we have what we have looked for. One who understands steel, however, knows that the real story of the manufacture will be told after a period of service. He will know that the steel which is worked to the center, as was the old steel rail of years ago, will last in the track and will stand up when a much larger section of rail rolled more rapidly may not give as good service. As the rail sections grow larger, their analogy to the railroad organization is apparent.

As the railroad grows larger, and as the larger railroads are grouped into numerous systems, the character of the problem itself changes and it becomes more and more difficult to reach to the center and make the record which is needed. Perhaps the railroads realize this, and that the proper management of the numerous combinations depends upon the growth of men to correspond with that of the combination, but results recently attained by officials who have been called upon to make records in high places in these combinations indicate that there is a tendency towards the superficial rolling process which cannot possibly reach the center of the masses because of lack of time. Time is required for anything that is worth while, and if anything in the industral field is worth while, it is to organize and operate a vast aggregation of business interests, such as a combination of railroads.

The records which are to be permanent will be those made by men who realize that it takes at least ten years to accomplish anything which is really worth doing. The man does not live who can lead a large railroad which has become slow in matters of progress into the front rank of present-day practice in a year or two. A very large salary may induce some to attempt it, and much may be accomplished by them, but if a man seriously attempts to revolutionize the management of a railroad in a year or two either he will fail for lack of physical strength or the work will be done superficially, with the truth to be revealed later.

The sort of record a railroad needs is that based upon a thorough, comprehensive plan which will bend individuals and methods without breaking them and will draw all interests together in a common effort to produce a truly great result. This result will not stand to the credit of one man. It will not be accomplished in a short time and will probably be conducted as a campaign of a successful war is conducted, with every point covered and provided for. The real record makers are those who will begin at the bottom and build their foundation, and necessarily some time will elapse before the structure itself takes form.

LARGE ELECTRIC AND STEAM LOCOMOTIVES.

A very valuable paper on this subject was presented at the February meeting of the New York Railroad Club by Mr. J. E. Muhlfeld, general superintendent motive power of the Baltimore and Ohio Railroad. Three important phases of the subject were considered, *i.e.*, it contained a report of the comparative performance for one year of large steam and electric locomotives under fairly similar conditions; also a statement of the essential requirements of the electric locomotive and its source of power, as suggested by the practical experience of the B. & O., to produce the proper efficiency and economy in operation for either passenger, freight or helper service; also a report on the service and results of the large Mallet compound locomotive. The locomotives compared were the two electric multiple unit locomotives, described on page 324 of our September, 1903, issue, which are specially designed freight train helping locomotives, and the large Mallet compound, which was described on the following pages of this journal: 167, May, 1904; 237, June, 1904; 262, July, 1904; 297, August, 1904; 249, July, 1905, and the performance of which was described on page 229, June, 1905. This engine was placed in service January 6, 1905. The following extracts are taken from Mr. Muhlfeld's paper.

COMPARATIVE PERFORMANCE.

Concerning the performance of the electric locomotives Mr. Muhlfeld said: Considering $1.25 per net ton as a base cost for fuel delivered at the power plant, the average total operating and maintenance expenses during the year for generating the current; the labor and material for the locomotive electrical and mechanical repairs; the engineer's wages; wiping, hostlering, inspecting, oiling and dispatching; lubricating and miscellaneous supplies, was approximately $34.50 per 100 miles run per locomotive. Of this amount the average cost of labor and material applied to each locomotive for the running and shop repairs, would be $3.20 or 52 per cent. for the electrical, and $2.90 or 48 per cent. for the mechanical, making a total average cost of $6.10 per 100 miles run for both the electrical and mechanical repairs.

The above figures do not take into consideration interest, depreciation, taxes nor insurance on the investment, nor do they include the expenses incident to the maintenance of such equipment as battery, feeders, third rail, bonding wires, insulation, safety cut-out switches, extra motors, etc., which is not required for steam locomotive operation. The wages for the conductor, or second man on the locomotive, have also been omitted.

For the Mallet compound the average total operating and maintenance expenses during the year for fuel, water, labor and material for the locomotive repairs, engineer's and fireman's wages, wiping, hostlering, washing boiler, inspecting and dispatching, lubricating and miscellaneous supplies, was approximately $24.50 per 100 miles run. To this figure can be added an allowance on account of general repairs and renewals to locomotive, mileage credited but not actually run, difference in cost of fuel delivered at power plant and on locomotive tender, and for the maintenance of fuel and water supply plants, and there will still be a large margin in favor of the steam as compared with electric locomotive performance, under fairly similar conditions.

ESSENTIAL REQUIREMENTS OF ELECTRIC LOCOMOTIVES.

From experience, to the present date, it would appear that an electric locomotive and its source of power, to produce the proper efficiency and economy in operation for either passenger, freight or helper service, should fulfill the following essential requirements:

A fire and collision resisting locomotive construction within the present clearance and weight limits; simple in design; reasonable in first cost; safe, reliable and economical for operation at varying speeds and power; and accessible for inspection, lubrication, cleaning, repairs and for replacement on track in event of derailment of any or all wheels, by the ordinary steam locomotive and car methods, without the necessity for the use of a power crane.

A locomotive that can be interchanged and operated over home and foreign tracks, which are suitable for steam locomotive or motor car equipment.

A locomotive composed of two or more interchangeable sections, each a duplicate of the other, and equipped so that each section may be operated from either end, and independently or jointly, with any number of coupled sections; the operation under any arrangement to be controlled from a single section by one engineer.

The elimination of pilot wheels and the concentration of the entire weight on the driver wheels, with a minimum weight per wheel at the rail of 25,000 lbs.; and an arrangement of driver wheels providing for a short rigid and a long flexible wheel base, without excessive end play at axle bearings.

The elimination of armatures from locomotive driver wheel axles and the transmission of power to driver wheels not less than 60-in. initial diameter without the use of gearing, in a manner that will insure the economical use of current at the motors for starting and running, and eliminate the accumulation of unbalanced pressure at the wheel and rail contacts, as well as the independent revolution of one or more pairs of driver wheels when coupled in series, which occurs as the driver wheels become slightly different in diameter due to ordinary wear or material, when making transition in current at motors, or when operating on slippery track or over rails, frogs and switches of varying wear, surface, alignment and elevation.

The least weight between the track and the locomotive frame carrying springs, to minimize the pressures, lateral thrusts and wear at the rail and wheel flanges.

A high center of gravity so that the vibration of the locomotive, due to the variation in surface, alignment, elevation and curvature of track can be absorbed by the weight suspended over the driver springs.

A proper proportion between the electrical, mechanical and dead equipment weights of the locomotive.

Locomotive motors compact, ventilated, cooled, protected from internal damage and mechanical injury, and of ample range of adjustment and capacity to permit of continuous operation at varying or full speed or power without excessive heating of armatures, commutators or fields above the temperature of the surrounding atmosphere. A thin, tough and elastic insulation material, unaffected by humidity or a temperature of 400° Fahrenheit, and having the requisite dielectric strength.

A development of the maximum locomotive power for rapid acceleration and regular working, requiring no transition, as from series to multiple, in the transmission of the current to the motors, and providing for a uniform increase or decrease in tractive power to prevent irregular drawbar stresses.

Suitable pumps to provide compressed air for the locomotive power brake, track sander, bell and signal operation, together with steam train heating device, and the other usual equipment.

Automatic positive devices on the locomotive to insure protection in event of accidental short circuit, or disablement of the engineer.

An arrangement on the locomotive which will automatically provide for electrical braking and return to the line for the use of pulling locomotives, a considerable percentage of the energy that is generated by trains descending grades, or stopping, and which energy is ordinarily wasted in destroying material and equipment by brake shoe action on wheels or rails.

A high potential current producing, and an aerial conveying system, reasonable in first cost and economical for maintenance; the generation of the electrical energy at a central plant for the least cost per kilowatt hour; the transmission of the lowest current over the minimum amount of metal contained in overhead contact lines, protected for weather, voltage and lightning conditions, and insuring continuous operation in event of line or equipment failure or accident; the conservative use of battery as storage for extra power that can be generated at small cost during light load and utilized to good advantage during intermittent and peak loads; the least number of transformer or convertor stations; the minimum feeder, conversion and resistance losses in current, and the elimination of electrolytic action.

ADVANTAGES OF THE MALLET COMPOUND.

The following are some of the results that can be obtained from this compound cylinder articulated type of freight locomotive, which cannot be duplicated by other single units of steam, electric or internal combustion locomotives now in use on American railroads:

A tractive power of about 84,000 lbs. for starting heavy trains and for a speed of 5 miles per hour; and of 74,000 lbs. at a speed of 10 miles per hour, placed under the control of one engineer and one fireman.

A self-contained machine generating the power necessary to develop its hauling capacity. With electric locomotives, where the source of power is separate from the machine which develops the hauling capacity, the first cost of the locomotive alone is, at present, about 50 per cent. greater per pound of tractive power developed under working load than for steam locomotives of the 2400 type. To this must be added the greater cost for repairs and operation per mile run for the electric locomotive, and the installation, maintenance and operation of a current producing, conveying, storage, converting and distributing system, which would not be required by either a steam or internal combustion locomotive, and all of which increase the capital and operating expenses very materially.

A total locomotive weight utilized for the development of tractive power in connection with a running gear, which makes the locomotive suitable for either hauling, pushing or braking freight trains containing the maximum paying load per foot of track space, over level or mountainous railroads of maximum curvature.

A maximum tractive power with a minimum rail pressure per driver wheel, on account of the total weight of 334,500 lbs. being distributed over 12 drivers, and a 30 ft. 6-in. total, with a 10-ft. rigid wheel base, resulting in minimum wear and tear on bridges, rails, ties and roadway. With electrical locomotives the excessive weight concentrated on a short rigid driver wheel base and below the springs, together with the extremely low center of gravity, results in extraordinary rail pressures, thrusts and wear.

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A minimum capital, repair, fuel, engine and train crew, oil, supply and dispatchment cost per locomotive, train, car or ton mile.

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STRANG GASOLINE ELECTRIC MOTOR CAR.

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A uniform turning movement to overcome journal friction of axles; rolling and flange friction of wheels; wave resistance of rail; atmospheric friction at ends and sides of rolling stock and inertia of train at time of starting, which will insure the minimum draft gear, machinery and boiler stresses, and reduce the tire and rail wear.

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Ability to move itself and train of one-half rating in the event one set of its machinery or engines becomes disabled.

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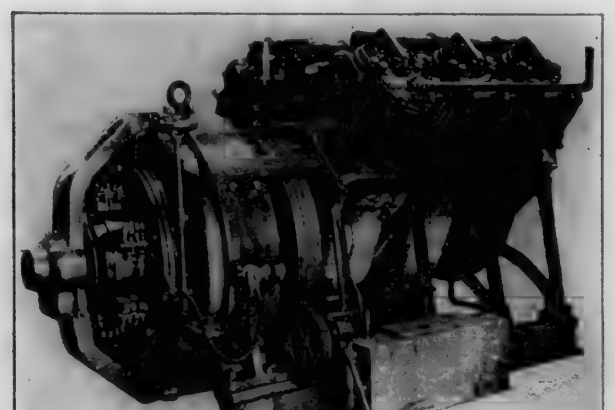
This car, which is illustrated herewith, is at present making a trip from New York to San Francisco for the purpose of exhibition and demonstration. For this reason it is of small



ENGINE AND GENERATOR, STRANG MOTOR CAR.

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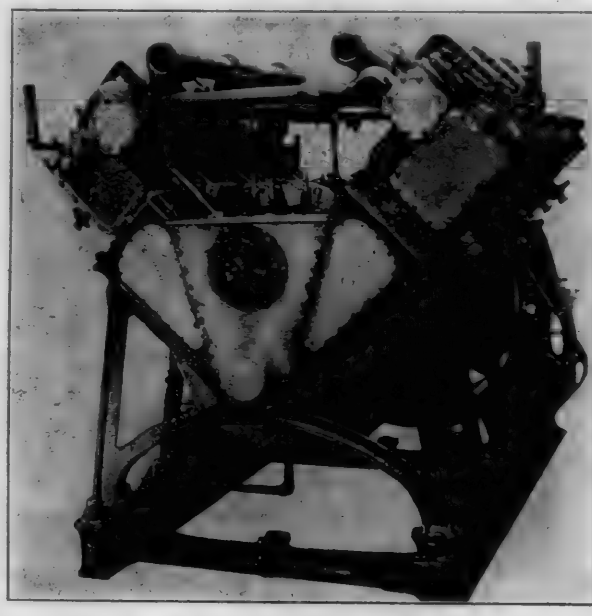
In brief, the Strang system employs an electric generator driven by a special design of six-cylinder gasoline engine, a storage battery, connected in parallel with the generator, and



END VIEW OF ENGINE, STRANG MOTOR CAR.

an ordinary series parallel control of standard railway motors on the trucks.

The engine, two views of which are shown herewith, is of the four cycle type and has six 8 by 10 in. cylinders. These cylinders are partially opposed, three on each side, and are set at an angle of 90° to each other. Care has been taken throughout the design to make every part as light as is consistent with the requisite strength and for this purpose all casings and parts which are not subjected to strain are made of aluminum and the other parts of cast steel as far as possible.

The vaporizer is arranged to work with either gasoline, kerosene, alcohol or crude oil, as may be desired. The ignition is of the high tension type and has one coil of special design for each cylinder, all being operated from one interrupter. The lubrication of all bearings is ample, as the oil is pumped from a reservoir beside the engine over the bearings to a filter above the reservoir, thus using it over and over again. The cylinders are water cooled, the circulation being by a centrifugal pump, which draws the water from a tank located in a vestibule at the center of the car and forces it through cylinder jackets and to radiating pipes on the roof. In cold weather the passenger compartment is heated by this jacket water. The

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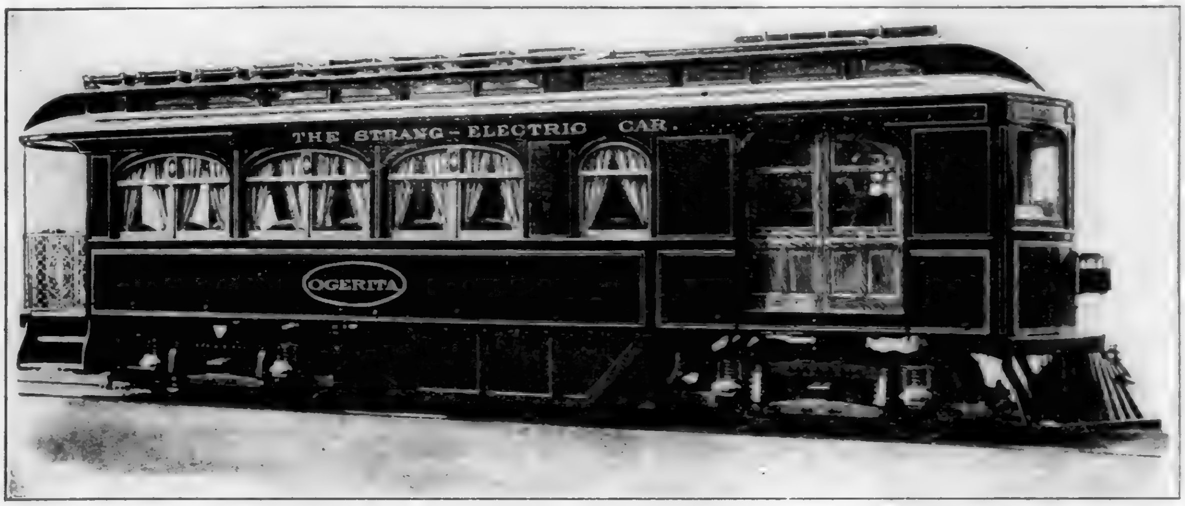

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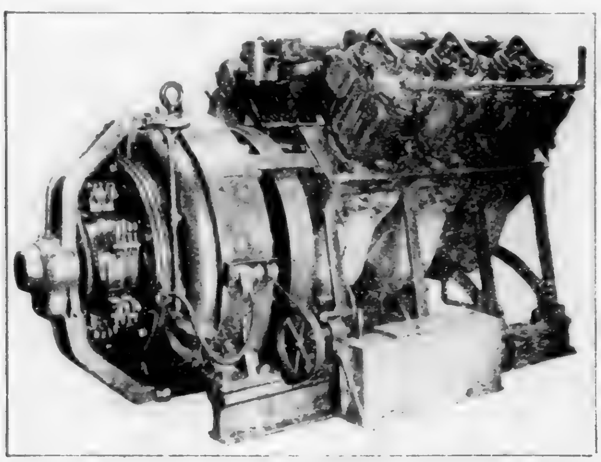

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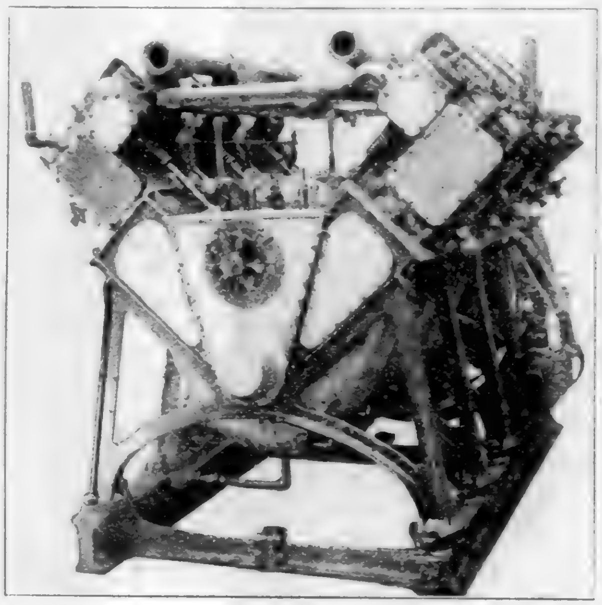


END VIEW OF ENGINE, STRANG MOTOR CAR.

The engine, two views of which are shown herewith, is of the four cycle type and has six 8 by 10 in. cylinders. These cylinders are partially opposed, three on each side, and are set at an angle of 90° to each other. Care has been taken throughout the design to make every part as light as is consistent with the requisite strength and for this purpose all casings and parts which are not subjected to strain are made of aluminum and the other parts of cast steel as far as possible.

The vaporizer is arranged to work with either gasoline, kerosene, alcohol or crude oil, as may be desired. The ignition is of the high tension type and has one coil of special design for each cylinder, all being operated from one interrupter. The lubrication of all bearings is ample, as the oil is pumped from a reservoir beside the engine over the bearings to a filter above the reservoir, thus using it over and over again. The cylinders are water cooled, the circulation being by a centrifugal pump, which draws the water from a tank located in a vestibule at the center of the car and forces it through cylinder jackets and to radiating pipes on the roof. In cold weather the passenger compartment is heated by this jacket water. The

heating system is so arranged that hot water is only in enough pipes to heat to the desired temperature.

The engine is direct connected to a 50 k.w. 250 volt direct current generator and on the trucks there are two 50 h.p. series wound motors of regular street railway type. The storage battery, which is placed in a cradle underneath the center of the car, consists of 112 cells having 200 ampere hours capacity. The pressure of 250 volts is used in place of the usual 500 in order to reduce the number of storage battery cells, each of which require about 2½ volts for charging and will discharge at a pressure of about 2 volts.

The storage battery, as above stated, is connected in parallel with the generator and the advantage of the whole system lies in the fact that an engine and generator are required which are of a size only large enough to take care of the normal operation of the car and the battery will help out at periods where extra power is required, such as at periods of acceleration and in ascending grades. The battery also takes care of the surplus current from the generator when the car is standing or descending a grade. Provision is made to prevent the batteries from becoming over-charged by an automatic governing device upon the engine, which depends entirely upon the condition of the batteries for its operation. Current from the batteries is used in starting the engine by using the generator as a motor.

The interior of the car is fitted out with easy chairs and attractive decorations. A controller is placed upon the rear platform as well as at the front of the car. The maximum speed is stated to be 50 miles per hour and the average gasoline consumption is .45 gallons per mile.

It weighs 39 tons total and is mounted on Brill No. 27 type E high speed trucks having rolled steel wheels.

STANDARD PACIFIC TYPE LOCOMOTIVE.

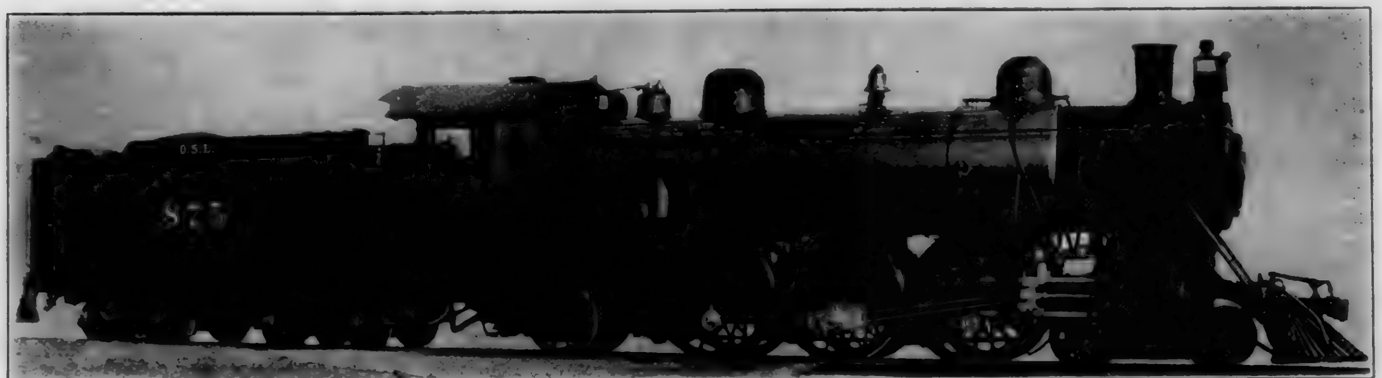
HARRIMAN LINES.

The Baldwin Locomotive Works are building 28 Pacific type locomotives for the Harriman Associated Lines, one of which is illustrated herewith.

These engines are constructed from the standard designs which were adopted by the associated lines last year, and which were completely illustrated and described in the AMERICAN ENGINEER AND RAILROAD JOURNAL, 1905, pages 154, 200, 250, 288, 322, 353, 400 and 441.

The standard designs were very carefully worked up in all details, and permit a very wide interchange of parts on different locomotives. In this connection it is of interest to note the parts on this Pacific type engine which are common to other types of locomotives on the associated lines which include the Union Pacific, Southern Pacific, Oregon Short Line, Chicago & Alton, Oregon Railroad & Navigation Company and the Kansas City Southern. The following are some of the more important parts common to the standard Atlantic, Pacific, consolidation and switch engines, with exceptions as noted: Eccentrics; cross heads, piston valves, except switch engines; driving boxes, except main, which is common to consolidation and Pacific type; truck wheels, except consolidation; smokebox arrangements; exhaust nozzle; petticoat pipe; general design of cab; grates; grate castings; boiler diameter, except consolidation; size of firebox, except switcher; four-wheel engine truck; truck axles; general design of frame and cylinders; general design of wheel centers and also boiler and engine fittings as far as possible.

The general dimensions, weights and ratios of this Pacific type locomotive are as follows:



STANDARD PACIFIC TYPE LOCOMOTIVE—OREGON SHORT LINE.

4—6—2 TYPE PASSENGER LOCOMOTIVE—OREGON SHORT LINE RAILROAD.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger.
Fuel	Bituminous coal.
Tractive power	29,920 lbs.
Weight in working order	222,000 lbs.
Weight on drivers	141,000 lbs.
Weight on leading truck	37,000 lbs.
Weight of engine and tender in working order	384,000 lbs.
Wheel base, driving	13 ft. 4 ins.
Wheel base, total	33 ft. 4 ins.
Wheel base, engine and tender	63 ft. 10½ ins.
RATIOS.	
Tractive weight ÷ tractive effort	4.7
Tractive effort x diam. drivers ÷ heating surface	754.
Heating surface ÷ grate area	61.
Total weight ÷ tractive effort	7.4
CYLINDERS.	
Diameter and stroke	22 by 28 ins.
Piston rod, diameter	4 ins.
VALVES.	
Kind	Piston.
Greatest travel	6 ins.
WHEELS.	
Driving, diameter over tires	77 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	10 by 12 ins.
Engine truck wheels, diameter	33½ ins.
Engine truck, journals	6 by 10 ins.
Trailing truck wheels, diameter	45 ins.
Trailing truck, journals	8 by 12 ins.
BOILER.	
Style	Straight.
Working pressure	200 lbs.
Outside diameter of first ring	70 ins.
Firebox, length and width	66 by 108 ins.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	5 ins.
Tubes, number and outside diameter	245 2¼ ins.
Tubes, length	20 ft.
Heating surface, tubes	2,874 sq. ft.
Heating surface, firebox	174 sq. ft.
Heating surface, total	3,048 sq. ft.
Grate area	49.5 sq. ft.
TENDER.	
Wheels, diameter	33½ ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	9,000 gals.
Coal capacity	10 tons.

LOW STEAM CONSUMPTION OF CORLISS COMPOUND ENGINE.—A recent test on one of the 7,500 h.p. twin vertical horizontal Reynolds' Corliss engines, of which nine have been in operation at the 59th Street Power Station of the Interborough Rapid Transit Company, New York, since 1902, showed a steam consumption of 11.96 lbs. per indicated h.p. hour. The engine developed 7,365.3 h.p. at 75 r.p.m. and 175 lbs. steam pressure with 25.52-in. vacuum in the condenser. These engines were built by Allis-Chalmers Company under a guarantee that they would not require more than 12.25 lbs. of dry steam per i.h.p. hour when indicating 7,500 h.p. at 75 r.p.m. and 175 lbs. pressure with 26-in. vacuum.

POWER REQUIRED BY MACHINE TOOLS, WITH SPECIAL REFERENCE TO INDIVIDUAL MOTOR DRIVE.

BY G. M. CAMPBELL.*

This article will not be a theoretical exposition of the subject in general but will rather present a few deductions from the various motor equipments in a modern shop, giving certain curves of power in connection therewith and various examples of every day practice in these shops. Most of the inferences that may be drawn from these records will be left for the reader to make as he sees fit.

There has been a large number of articles written on the amount of power required by machine tools, some of them of but little service but others of the very highest value, and in these articles the horse power required by certain machines varies greatly. This is as might be expected. A certain machine tool, if used to the limit, would require the same horse power in every case, but the same machine in different shops is used for different purposes; in one shop it might be used only for coarse roughing cuts whereas in another it might be used wholly for light finishing cuts; the horse power requirements would be widely different. It is thus necessary to study the special conditions in every instance. In general shops where practically little is done except repair work, such for example as locomotive repair shops, small jobbing concerns, etc., the size of motor required is smaller than would be required for the same tools in ordinary manufacturing shops, and motors in these again would be smaller than would be required for similar tools in large manufacturing shops where the output may be considered practically raw material, but where a certain amount of roughing work is done, for example, mills whose output is car axles, rough turned shafting, armor plate, etc. Tools in such plants would have relatively large capacity motors.

In machine tool work speed variation is essential, and in a machine driven by an individual motor part of the speed variation must be obtained in the motor itself if efficient speed control is required. The range of speed required in some machines may be quite limited, on account of the particular class of work for which the machine is used, and in such a case the full range of speed could be supplied by the motor. On the other hand, the speed variation required may be so great that it is impossible to supply it all by the motor. For example; the 90-in. lathe referred to in Fig. 4 has spindle speed ratios of about 21 to 1, and the 20-in. lathe referred to in Fig. 5 has spindle speed ratios of about 27 to 1. It is therefore necessary to get this speed range changed by proper gearing into such steps that the whole range in each step can be obtained in the motor. In the 20-in. lathe referred to, four runs of gears were used, three changes being necessary to get the total range of 27 to 1 in spindle speed. Calling these gear runs A, B, C, and D; run B would give a spindle speed about three times A; run C about three times B and run D about three times C.

This jump in speed of 300 per cent. in each case is of course inadmissible if taken in one jump, therefore the motor is given a speed variation of about 3 to 1. The machine is running with run of gears A and the motor is at its initial speed, then this speed is gradually increased by any desired increment until the motor is running at about three times its initial speed. At this point the gear run is changed to B and the motor dropped back to its initial speed, the machine spindle would then be revolving at about the same rate as at the high speed run A. A similar change is made to C and to D so that the complete range is obtained in gradual steps with small increments.

Just what range of speed is required in the motor cannot be definitely stated for all conditions. If a total speed range of 6 to 1 is required in a machine, it might be advisable under certain conditions to obtain this total range in the motor, but as a general rule the writer believes it would be advisable to use at least two runs of gears when the speed change required exceeds to 4 to 1, and that a somewhat better and more efficient design can be obtained when the speed change required in the motor is limited to about 3 to 1. The larger the speed range the larger the motor as is shown in Fig. 2, and of course the greater the price, also the disproportion between size of motor and size of machine increases.

The controller necessary to enable the speed change to be obtained in proper increments will vary according to the range required and the size of the increment. It is feasible to work to within 10 per cent. change of speed and consequently a 10 per cent. increment would be desirable. If 10 per cent. increments are used the number of points of the controller would be obtained from the formula:

$$1.\ 1^{n-2} = \text{Speed range in motor.}$$

Where n is the number of points in controller, "off" point being counted as one point. This would give results as follows:

Speed Range.	Controller Points.
3	14
4	17
5	19
6	21

If the motor is a reversing one, then to this number of forward motion points must be added the required number of back motion points; usually one third to one-half the number of forward, so it is seen that the controller would become unwieldly in size or the speed increment would have to be increased above 10 per cent. In the Pittsburgh and Lake Erie shops the speed increment was about 10 per cent. and the speed range required in the motor somewhat less than 3 to 1, the necessary number of runs of gears being used to give the total range in the machine. The maximum number of runs used was four.

This speed change in the motor, which is such a requisite for individual motor drive, may be obtained in several ways, the three principal ones at present being: Multi-voltage or four-wire system; two equal voltage or three-wire system; single voltage or two-wire system. The proper treatment of these various systems would require a paper in itself and cannot be dealt with here. In all the systems the size of motor required is about the same. For certain classes of work one system may be better than another; for reciprocating machine tools, for instance, the multi-voltage system is undoubtedly advantageous. Another very strong point in favor of the multi-voltage system is that standard motors are used, so that repairs can be easily made without danger of mistake in mixing armatures and fields. This system, however, labors under two disadvantages. First, the power house machinery and the distribution lines are somewhat more complicated than the other systems, but though this is a disadvantage it is very greatly overestimated. Second, it is comparatively inflexible compared to a two-wire system. Any two-wire installation already in service can incorporate without any trouble any number of variable speed single voltage motors, whereas before a single motor operated on the multi-voltage system can be put into service, a three part balancer, or motor generator set, has to be installed and also special wiring from power house to motor. This is a great disadvantage and one almost fatal to the expansion of multi-voltage control. The three-wire system is a cross between a multi-voltage and a two-wire, with part of the good points and part of the bad points of each. At the Pittsburgh and Lake Erie shops the multi-voltage system is in use, and at the time it was installed, 1902-3, it was undoubtedly the best system on the market. It has fulfilled all expectations and gives accurately the speed control required, and, owing to the substantial manner in which it was installed, has been maintained at a minimum cost. As to the future, the writer is of the opinion that the single voltage system will predominate.

One factor which has a decided bearing, not on the amount of power required by the tool but on the power or size of the motor to be provided, is the variation in speed required. In determining the size of the motor for a variable speed machine, it must be borne in mind that as the speed range increases the size of motor also increases for a certain horse power output throughout the range, and it must be distinctly

*From a paper read before the Mechanical Section of Engineers' Society of Western Pennsylvania.

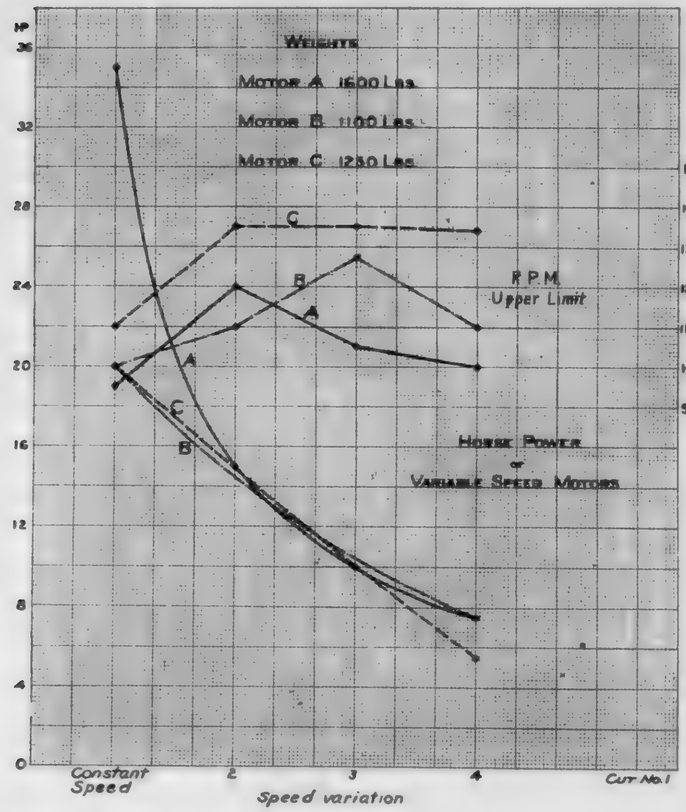


FIG. 1.

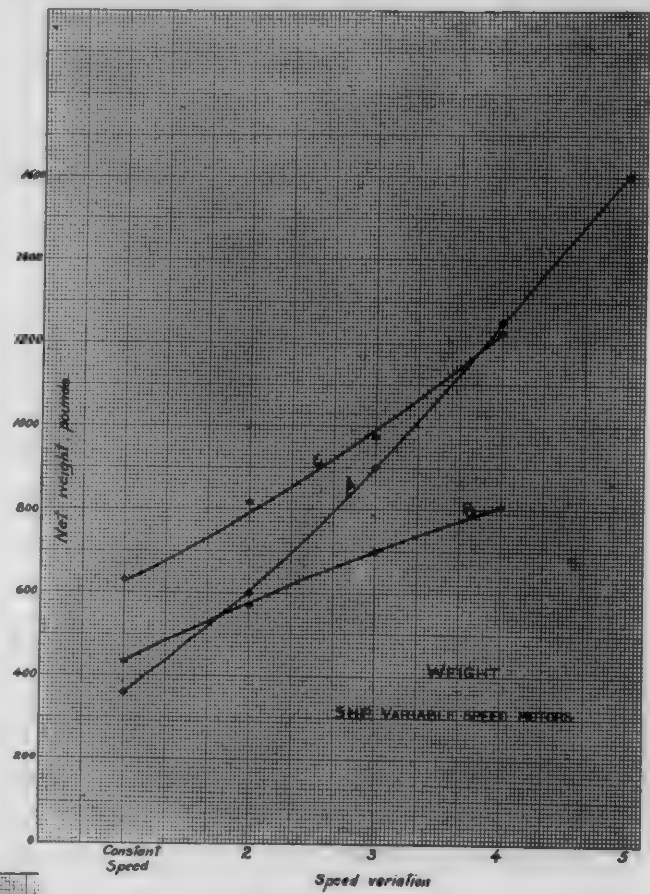


FIG. 2.

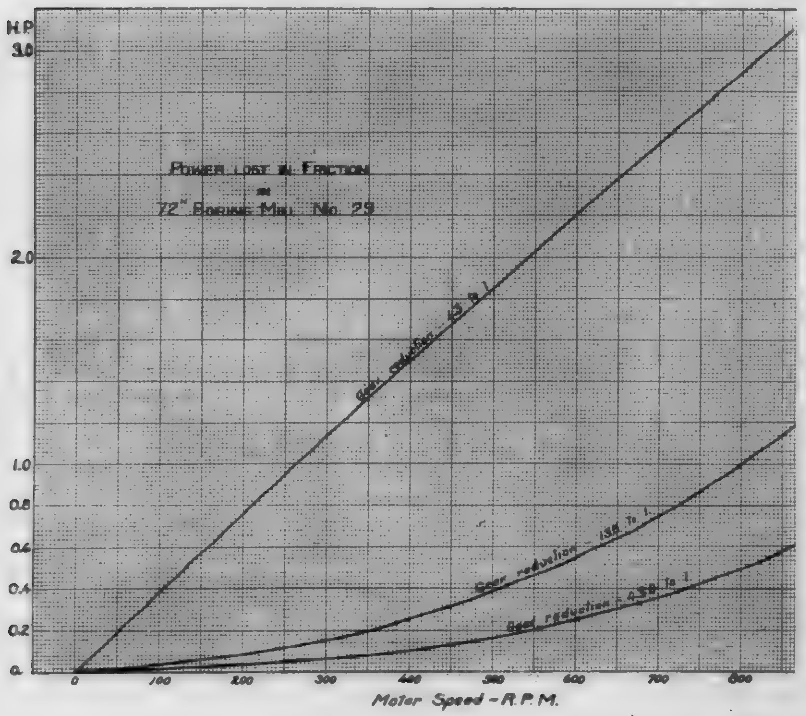


FIG. 3.

more in proportion to its weight, but the drop from 35 to 15 h.p. when a 2 to 1 ratio is required is very great, whereas, in the other two motors the drop from 20 to 15 is proportionately small. Motor A would be sold to one customer as a 35 h.p. constant speed motor and to another as a 7½ h.p., 4 to 1 variable speed motor, but the two prices would be practically identical.

If, on the other hand, a certain horse power is required then from Fig. 2 it may be seen how the weight (also the price though not in the same ratio) will vary as the speed variation changes. When the motor is to run at constant speed a 5 h.p. motor, of a certain make, curve A would weigh about 360 lbs. without rail base or pulley, whereas the same capacity motor but with a speed variation of 5 to 1 would weigh 1,600 lbs., being then the motor given by curves A and B in Fig. 1. Curve B is for the same capacity interpolar motor, of another make, weight ranging from 430 lbs., constant speed, to 810 lbs. at 4 to 1 range of speed. Curve C is for a three-wire motor, weight ranging from 625 to 1,225 lbs. These particular motors are taken simply as examples;

understood that a 5 h.p. motor with a 2 to 1 range of speed is an entirely different motor from a 5 h.p. motor with a 6 to 1 range of speed. Manufacturers advertise that they can provide variable speed motors with a speed range of, say, 5 to 1, but they do not at the same time state that they provide perhaps a 30 h.p. motor frame and mark it 5 h. p., that is they provide a size of motor which under ordinary conditions of voltage, field and armature winding would provide 30 h.p. with the standard rise of temperature on 24 hour service.

As an example of this Fig. 1 is given showing the rating for variable speed motors built by three different companies. All three motors are for use on a two-wire system with speed control by field resistance; Motor B is an interpolar motor. When running as a constant speed motor, A has a capacity

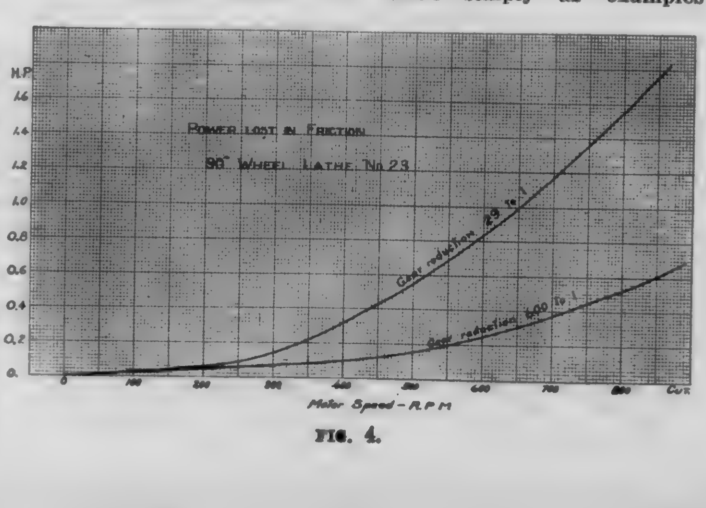


FIG. 4.

the proportions given are special and not general, other types and makes of motors would give different motor curves. The writer does not guarantee the correctness of the figures as published in the manufacturers' catalogs as extracted above. From these examples it is quite evident that when it is stated a certain machine requires, for example, a 5 h.p. motor, such a statement means very little unless the conditions under which the motor is operated or the particular basis on which the motor is rated is given.

Other conditions being the same, the power taken by a machine, after allowance is made for friction losses, will vary

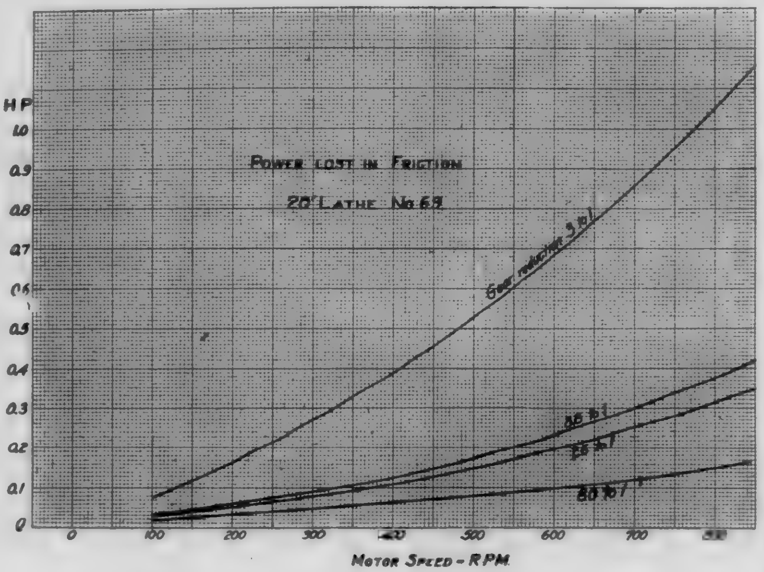


FIG. 5.

approximately as the speed and cut and therefore as the weight of metal removed, consequently in fitting motors to tools due allowance must be made for high speeds and maximum cuts, bearing in mind the coming universal use of high speed tool steels and the increase in rigidity of machines. A formula for the amount of power absorbed in cutting may be stated thus:

HP = K W

where HP = Horse power

K = A constant, depending on the kind and grade of material.

W = Weight of metal, pounds, removed per minute.

Values of K may be taken as follows:

K = 2.5 for hard steel.
= 2.0 for wrought iron.
= 1.8 for soft steel.
= 1.4 for cast iron.

HARD STEEL.

Machine.	Cut: Feed Inches	Cut: Depth Inches	Speed Ft. per Min.	Weight Removed Lbs. pr M.	H.P. Actual	H.P. From Formula.
72" Wheel Lathe No. 14.	1/12	3/16 & 1/4	13.7	1.69	4.5	4.2
	1/8	3/16 & 1/4	11.6	2.15	6.4	5.4
	3/16	5/16 & 3/8	13.2	5.55	8.4	13.9
	3/16	3/8 & 3/8	13.2	6.3	12.0	15.7
90" Wheel Lathe No. 23.	3/16	3/16 & 3/16	13.0	3.1	12.0	7.7
	3/16	5/16 & 5/16	8.8	3.5	8.1	8.7
	1/5	5/16 & 1/4	10.5	4.0	7.3	10.0
	1/5	1/4 & 1/4	15.5	5.3	9.0	13.2
	1/5	3/8 & 3/8	12.3	6.3	13.4	15.7
19" Slotter No. 77	1/32	1/4	30.0	0.8	2.0	2.0
	1/32	1/4	28.8	0.76	1.7	1.9
					84.8	98.4

SOFT STEEL.

Machine.	Cut: Feed Inches	Cut: Depth Inches	Speed Ft. per Min.	Weight Removed Lbs. pr M.	H.P. Actual	H.P. From Formula.
60" Planer No. 52	1/6	1/4	25.5	3.62	5.9	6.5
	1/6	1/4	25.7	3.65	6.5	6.6
24" Shaper No. 64	1/16	3/16	26.7	1.46	3.4	2.5
	1/16	1/8	37.5	1.00	2.7	1.8
	1/16	1/8	41.7	1.11	2.6	2.0
	1/8	1/16 & 1/32	44	1.76	2.9	3.2
	3/16	1/32 & 1/16	40	2.38	2.6	4.3
72" Boring Mill No. 29	1/8	1/8 & 1/8	51	5.41	9.6	9.7
	1/8	3/16 & 3/16	48	7.65	12.7	13.7
	1/8	3/16	47	3.75	7.2	6.8
19" Slotter No. 77	1/32	3/8	23.3	0.93	1.3	1.7
	1/32	3/8	23.3	0.93	2.1	1.7
42" Lathe No. 10	1/16	1/4	44	2.33	3.8	4.2
	1/16	1/8	44	1.17	1.7	1.9
	1/16	1/8	44	1.17	2.6	1.9

This formula is simply a general one, the power required in any particular case will vary perhaps 100 per cent., according to the condition of the cutting tool. To show how this formula applies, examples in tables* below are given. These examples are taken at random from various machines tested and under ordinary conditions of shop working, they are not results of special tests. The machines, it will be noted, include several different types, some had one tool working, some two. The horse power actually taken for the cut was obtained by deducting from the total power absorbed by the machine the power required to run the machine light at the same speed. This is not quite correct in some cases, for example, in drilling, as will be shown later.

There is considerable discrepancy in some of the figures; that is as might be expected; but in general the agreement is sufficiently close to show that the formula is a reasonable one for arriving at the approximate horse power required for doing the actual work. The readings for hard steel are rather erratic: this is quite natural, as the grade of steel in wheels varies widely; some of the material in that class should evidently be in the soft steel class. The figures for the drill presses are also rather divergent; this is especially the case in drilling, but not so much so in enlarging. The main reason for this is the inaccuracy of the light load losses. The friction loss of the machine running idle is not the same as the friction loss when the machine is working. This friction loss should have been obtained by putting in a noncutting drill and applying the pressure.

Another factor which enters into the capacity of the motor required is the friction loss of the machine itself. This is a factor impossible to predetermine, but fortunately is not very large except on very large machines; it depends greatly on the gear reduction. A few examples of friction losses will serve to show the general run

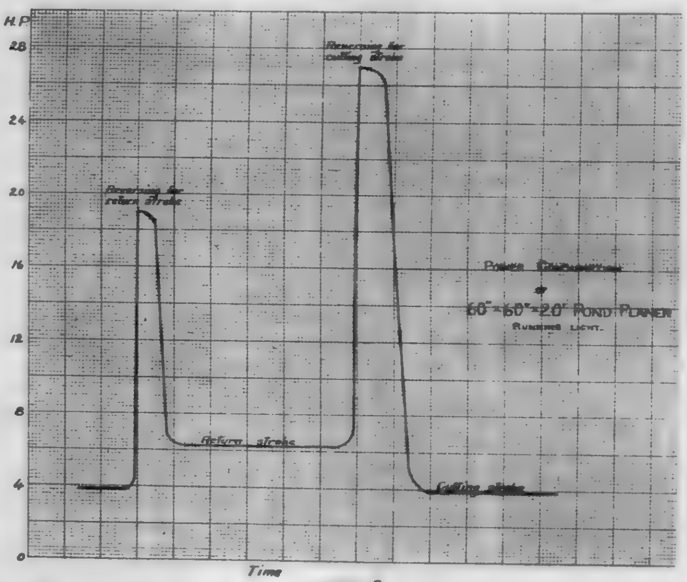


FIG. 6.

of such losses; the power last in other machines may be assumed by comparison.

Fig. 3 shows the power lost in friction in Pittsburgh and Lake Erie tool No. 29, a 72-in. Pond boring mill. There is a difference in lost power in the different gear ratios ranging from 2.9 h.p. for the high speed spindle to 0.5 h.p. for the low speed spindle with motor running at the same speed, 800 revolutions per minute. The spindle speeds for a loss of 0.5 h.p. are 3.14, 4.22 and 1.86, respectively, showing that the loss in friction is not directly proportional either to motor speed or spindle speed. This holds true for all tools.

Fig. 4 is for tool No. 23, a 90-in. Putnam driving wheel lathe. This is quite a large machine, but the friction loss is small, only 1.6 h.p. maximum for high spindle speed and 0.55 h.p. for low spindle speed. Although the gear reductions vary

*Because of lack of space part of these tables only are reproduced here.

considerably, 29 to 1 and 600 to 1, yet the total actual difference in lost power is not very large.

Fig. 5 is for a 20-in. by 11 ft. Putnam lathe, gear reduction varying from 3-1 to 80-1. The maximum loss is about 1.2 h.p.

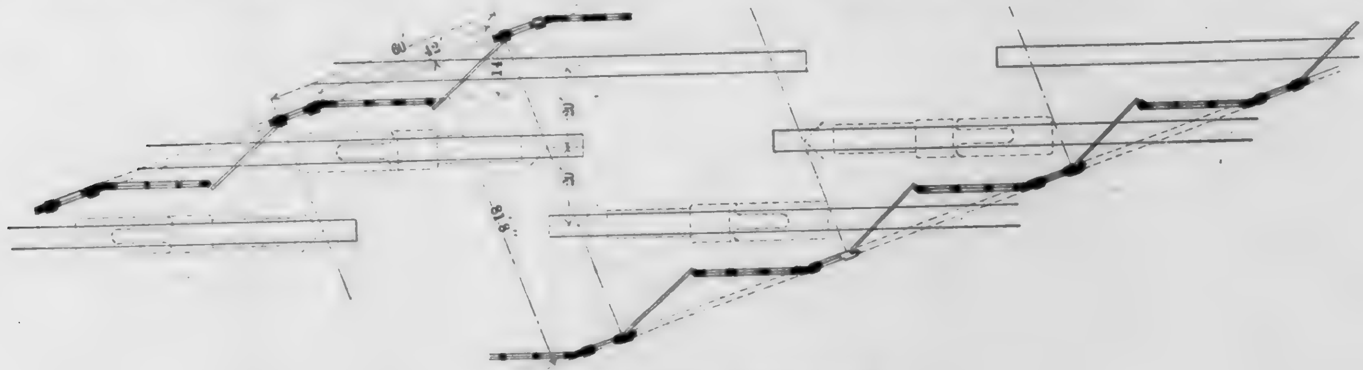
Fig. 6 shows incidentally the power lost in a 60-in. planer; Figs. 8 and 9, in punches; Figs. 15, 16 and 17, in some woodworking tools.

Similar curves could be given for a large number of machines, but these are sufficient to show the general trend of the losses, especially as they show that the losses are small, except when the spindle or table is running at top speed. At the high spindle speed it is rather unlikely that a maximum cut is to be taken, but in all probability only light finishing cuts or polishing, so that in general the power lost in friction in the machine may be neglected in considering the question of size of motor required.

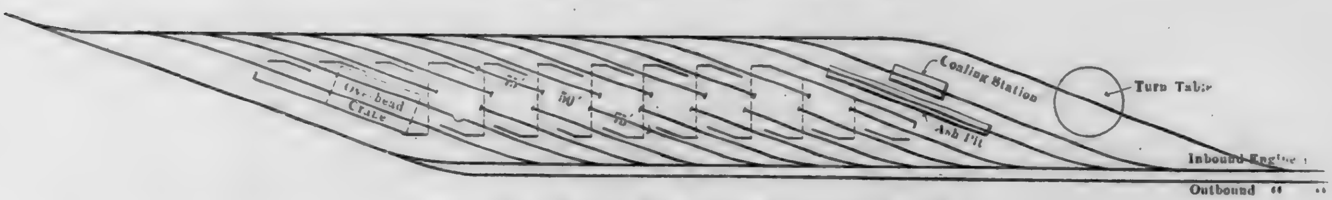
(To be continued.)

A NEW FORM OF ENGINE HOUSE.

The problem of housing locomotives to provide satisfactory storage, facilities for repairs and for quickly handling them into and out of the house, of such form as to be easily heated and ventilated, is one which has taken the attention of railroad men for several years. Several houses of rectangular form have been built and are now in service. These require transfer tables and in order to avoid this and to provide convenient means of extension, a design has been suggested by Mr. J. J. Turner, third vice-president of the Pennsylvania Lines West of Pittsburg, which he has called the Echelon house, the basis of which is a parallelogram. The arrangement illustrated provides a building with tracks running through it, the walls of the building being so constructed as to provide doors for each track, the plan having been developed under the direction of Mr. Trimble, chief engineer of maintenance of way of the Pennsylvania Lines West of Pittsburg. The house itself lies between two parallel tracks and encloses a portion of "ladder" tracks between the main tracks, the house being entered from either side. At one end and outside of the building is a turn-table, a coal station and an ash-pit. At the other end and inside of the building are two tracks running clear through the building, over which an electric travelling crane is located. The other tracks do not extend across an open space at the center of the building, which provides a passage way from end to end. With tracks located at 20-ft. centers considerable space is provided both inside and outside of the house for necessary repair work. The word Echelon is used to designate this construction because of the character of the walls, and the construction used to avoid making the doors too large. It is understood that the idea has not yet been put into the form of construction. It, however, furnishes an interesting study which is now under consideration.



PART PLAN OF ECHELON ENGINE HOUSE.



LAY-OUT OF TRACKS FOR ECHELON ENGINE HOUSE.

THE REPAIRING OF LOCOMOTIVE FRAMES.*

A few years ago the wrought iron frames that have done so well for half a century were universally used. The failure of these was of rare occurrence, and was easily repaired in the blacksmith shop. To-day we have the low carbon cast-steel frame with all its imperfections. Another innovation is the welding of broken frames on the engine with oil for fuel, or with aluminum thermit.

Evidently the steel frame will be the frame for the future, for the reason that it can be produced much cheaper than wrought-iron forged frames. Future developments may bring the steel frame to such a standard that it will resist the strain to which it is subjected as well as the forged wrought-iron frame. From my point of view and the many failures that have come to my notice in the past two years, the steel frame has not yet reached the standard that the wrought-iron frame has. Many of the steel frames break at the intersection of the pedestal to the back bone of the frame where the main driving axle is located. As this failure often takes place with our largest engine frame, it is evident that the severest strain comes at this point, and it cannot be expected that an ordinary weld at this point will be stronger than the original solid material. When a broken steel frame is placed in the blacksmith shop, the best method practical to strengthen this portion of the frame should be adopted, regardless of extra expense. The method adopted in the Southern Pacific shops is to forge a new piece of the best quality of iron and cut out the defective portion; weld in a new "T" piece with the fiber flowing in the direction of the strain to which this portion is subjected. By this method we have to make three welds. This may look like a roundabout way of repairing the fracture. The object is to get a sound piece of iron at the point where failures continually occur in the steel frame. The method adopted for welding the new piece into the steel frame is first to weld a piece of iron about an inch thick on to the different ends of the frame at the proper angle to receive the V-shaped piece. By this method we have for our main welds iron to iron to receive the V-shaped piece.

Recently we have been changing many of our compound

*From a paper read by Mr. S. Uren before the National Railroad Blacksmiths' Association.

locomotives to simple engines. To accomplish this it became necessary to lengthen the front end of the steel frames as shown in Fig. 1. The following method is used at the Sacramento shops to produce the new iron portion. First, the part C, Fig. 1, is produced by lap-welding a T piece, one-half the thickness required, then laying two of these T pieces together as shown at B. They are welded together under a steam hammer after being heated in a reverberatory furnace, producing the shape shown at C, in which the fiber flows in the same direction as the strains. The upper portion of the frame shown at D is made from solid material and with a side projection, which measures about 5 in. The parts C and D are then welded together to produce the forward portion of the wrought-iron frame as shown at E, Fig. 1. This new end is then welded on to the steel portion of the frame as shown in Fig. 2.

When preparing the steel end of the frame for the final weld, a piece of iron is welded on about 1 in. thick as shown at E, Fig. 2. This method leaves the two ends of the frame to be welded of the same material and shaped to receive the pieces G and F. The V piece, F, is welded in the cavity for the purpose of insuring a perfect weld in the center of the bar. The piece G is made with an angle of about 110 deg., and when welded into the cavity under the steam hammer is almost equivalent to a lap weld. On our system 40 of these iron to steel frames have been in service a year. Only one has come to the shop broken at the weld. I am under the impression that this break was caused by the steel frame breaking on the opposite side as no sign of the weld presented itself in the fracture.

The welding of frames with oil, without removing them from the engine, has caused me to become somewhat skeptical, as well as many of our members, regarding this method. After reading the report of the committee on this subject, I must concede they have done well; however, it is remarkable that of all the welds noted in the reports which have been made by this method, there has been only one failure. Great claims are made by some of our California shops for this method of repairing frames. I know of several cases of frames welded by this method that have not run ten miles before the welds parted. The engine returned to the shops and the frames were removed and properly welded in the blacksmith shop. Certainly a good welding heat can be produced by this method in members of frames that are accessible; however, I am opposed to butt welding or any other method of welding in the blacksmith shop, after the iron is brought to a welding heat, without the proper lamination.

Iron, when brought to a high heat, becomes disintegrated. The molecular structure is impaired and lamination is the only method that will produce the original structure. In my opinion the same conditions exist in welding frames on the engine where lamination is impracticable. I coincide with the views of Mr. McCaslin. If the metal has to be brought to a welding heat, the proper place is on the anvil. If a first class weld can be made on a steel or iron frame by this method, the same method would be applicable to other members of the locomotive. I do not think there is a member of this convention who would attempt to weld a main or side rod of an engine by this method.

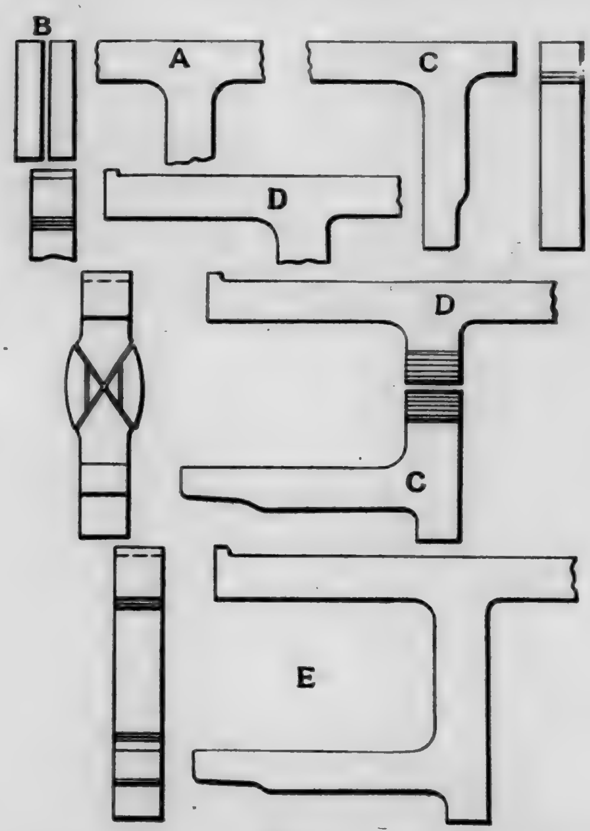


FIG. 1.

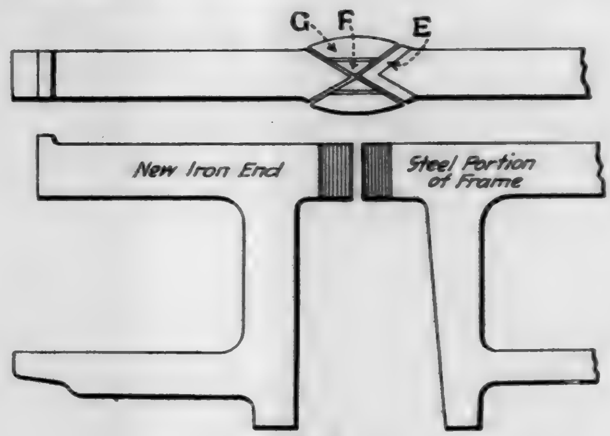


FIG. 2.

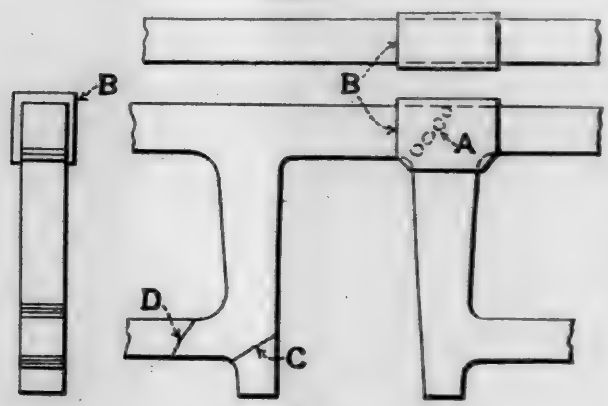


FIG. 3.

REPAIRING LOCOMOTIVE FRAMES.

Another innovation in the art of blacksmithing is the repairing of frames on the engine by the thermit method. This, above all other methods, is the simplest and quickest, and from my point of view is the best; forge, anvil and steam hammen excepted. At the present time the thermit method is in its experimental stages; it does not require an experienced smith to repair a frame on the engine by this process. The most particular part of making the preparations for the weld is the making of the mold to fit perfectly around the part of the frame to be welded. This is usually done by a moulder. The moulds should be made in halves and bolted together, so that all joints are perfectly tight. By this method of repairing we not only form a perfect union of the broken sections but we can also reinforce the weak points with a collar projecting on each side of the fracture.

The first experiment in the Sacramento shops of mending a frame with thermit was tried April 14, 1905, on engine No. 287, the longest engine on the system. The frame was broken at the junction of the pedestal to the back as shown at A, in Fig. 3. The first preparation made to repair the frame was to drill a series of ⅝ in. holes through the

broken section as shown. The holes being drilled at right angles to each other, produced a number of small facing projections. The ends of these projections were cut off so as to leave a ⅜ in. opening. A jackscrew was then placed between the pedestal, spreading the crack ⅛ in. A wooden pattern was made. This had the same contour as the portion of the frame to be repaired, and had such projections on it as were required to produce the reinforcement desired. Eleven ounces of thermit were placed in the crucible for every cubic inch of space in the mould. The space in the mould for the reinforced portion as well as for the parts to be welded were included in determining the amount of thermit to be used. Before igniting the thermit the ends of the parts to be welded should be warmed with an oil burner. A collar ¾ in. thick, as shown at B, Fig. 3, was left around the broken section. This welded frame has been in service up to the present time without showing the slightest defect, and eight welds have since been made by this process and not one of them has failed.

HIGH SPEED STEEL TWIST DRILLS.

The following is taken from a paper on "The Practical Use and Economy of High Speed Steel," presented by Mr. J. M. Gledhill, of the Sir W. G. Armstrong, Whitworth & Co., Ltd., before the Glasgow and West of Scotland Foremen Engineers' and Ironworkers' Association.

Perhaps one of the most useful of all the applications following the development of high-speed steel has been the manufacture of twist drills from it. In former days many attempts were made to produce twist drills from the ordinary self-hardening steel with usually but indifferent success.

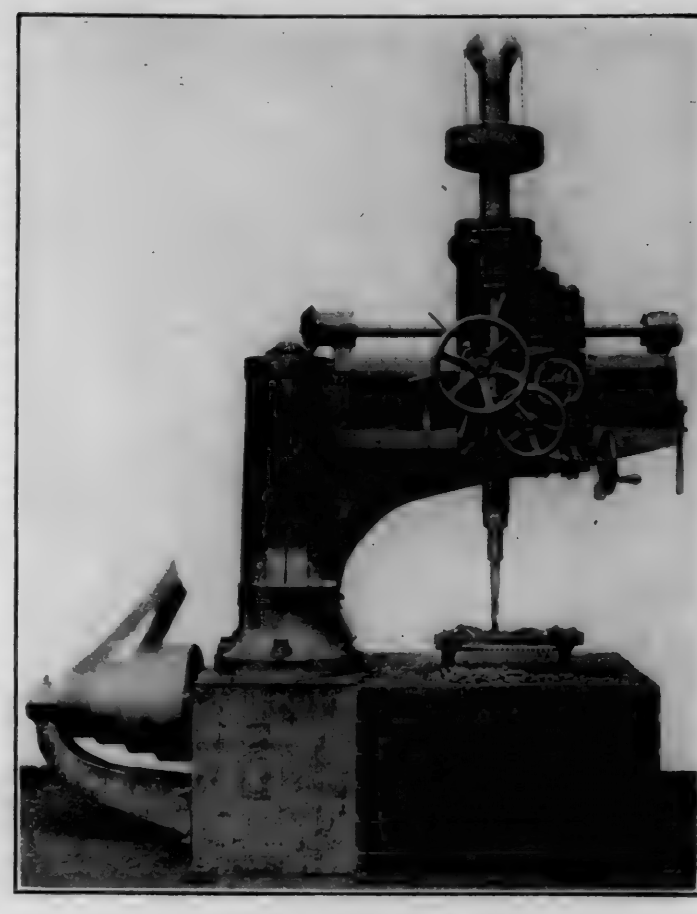


FIG. 1.—HIGH SPEED RADIAL DRILLING MACHINE.

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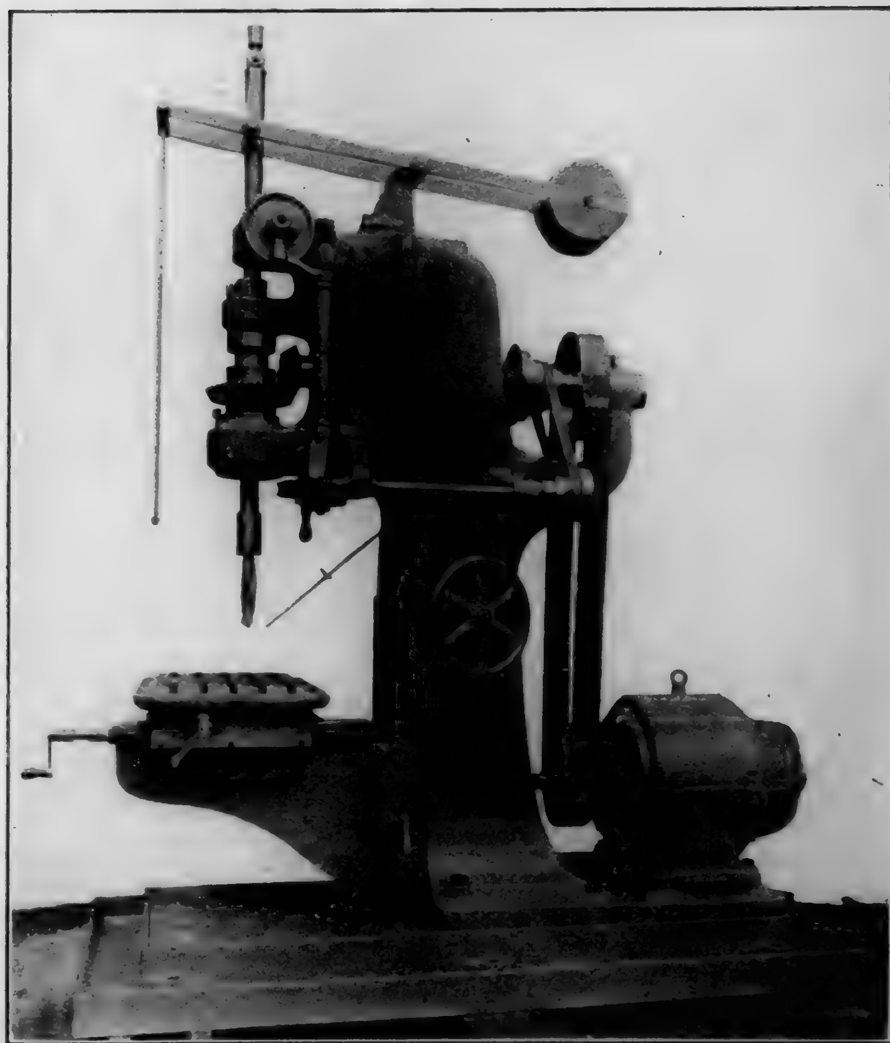

FIG. 3.—HIGH SPEED DRILLING MACHINE—400—¾ INCH HOLES DRILLED THROUGH 3 IN. CAST IRON AT 18 IN. FEED PER MINUTE WITHOUT INJURING DRILL.

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⅝ "	"	497	81.3	46	10.8	50	Gcod
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⅜ "	"	497	48.8	46	10.8	50	Gcod
¼ "	"	497	32.5	46	10.8	28	End of drill broke
25/32 "	2-in. Cast Iron Plate.	630	129.0	35	18	400	Good

NOTE.—497 revolutions represent the maximum speed of machine.

The trials on cast iron were made at the Liege Exhibition in the machine illustrated in Fig. 3. These results it will be seen show the high-speed drills to possess great torsional strength, for with a feed of 46 cuts per inch (0.21 in. per revolution) when drilling steel of the strength and depth stated, and with the size of drills used, the test in this respect is indeed a severe one. Of course it should not be

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Illustrations of the great superiority of "A W." high-speed drills over the ordinary carbon steel drills are furnished by the examples given below. Drilling the holes in pyrometer test cylinders, at a speed of 240 r.p.m., a drill of ordinary quality drilled 104 holes without grinding, whereas an "A W." drill, used under exactly the same conditions drilled 1,126 holes without grinding, showing an advantage of nearly 5 times in favor of the high-speed drill. The drills are ⅜ in. diameter, used in an automatic machine and drill 1¼ ins. deep through mild steel. When using ordinary drills it was found that they did not withstand the stresses so well as the "A. W." drill.

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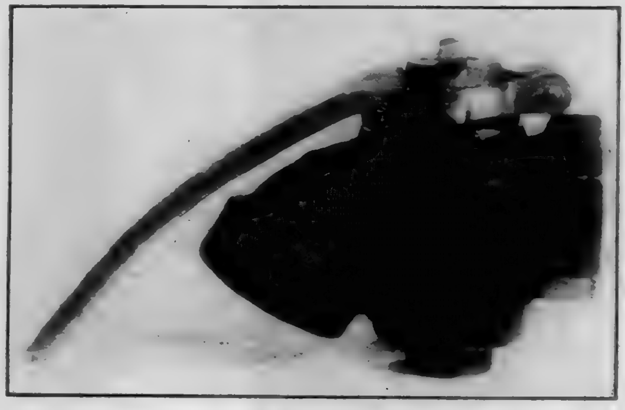
LOCK HANDLE FOR ANGLE COCKS.

There seems to be very little question but that wrecks are caused due to angle cocks used in connection with the train air brake apparatus becoming accidentally closed. This is usually caused by loose train pipes. To prevent accidents of this kind, Messrs. Inches and Hosker, of Kamboys, B. C., have patented a simple lock handle, which is interchangeable with and can readily be substituted for the handle of angle cocks used on the train pipe in connection with the Westinghouse



HANDLE LOCKED IN THE WIDE OPEN POSITION.

air brake apparatus. This handle is so designed that it will be locked when the valve is in the open position unless it is deliberately intended to move it and close the valve.

The body of the stop cock has two lugs or stops, and the ordinary handle has a lug on it which comes in contact with the stops on the body, limiting the travel of the handle to one-quarter of a revolution, and stopping the valve either in a closed or wide-open position. The new handle consists of two parts, as shown in the engravings. One of the illustrations shows the handle in the locked wide-open position, while the

HANDLE UNLOCKED.

other shows the handle unlocked so that the valve may be closed. The detent, or lug E, on the handle comes in contact with a lug or stop on the body when the valve is wide

broken section as shown. The holes being drilled at right angles to each other, produced a number of small facing projections. The ends of these projections were cut off so as to leave a ⅜ in. opening. A jackscrew was then placed between the pedestal, spreading the crack ⅛ in. A wooden pattern was made. This had the same contour as the portion of the frame to be repaired, and had such projections on it as were required to produce the reinforcement desired. Eleven ounces of thermit were placed in the crucible for every cubic inch of space in the mould. The space in the mould for the reinforced portion as well as for the parts to be welded were included in determining the amount of thermit to be used. Before igniting the thermit the ends of the parts to be welded should be warmed with an oil burner. A collar ¾ in. thick, as shown at B, Fig. 3, was left around the broken section. This welded frame has been in service up to the present time without showing the slightest defect, and eight welds have since been made by this process and not one of them has failed.

HIGH SPEED STEEL TWIST DRILLS.

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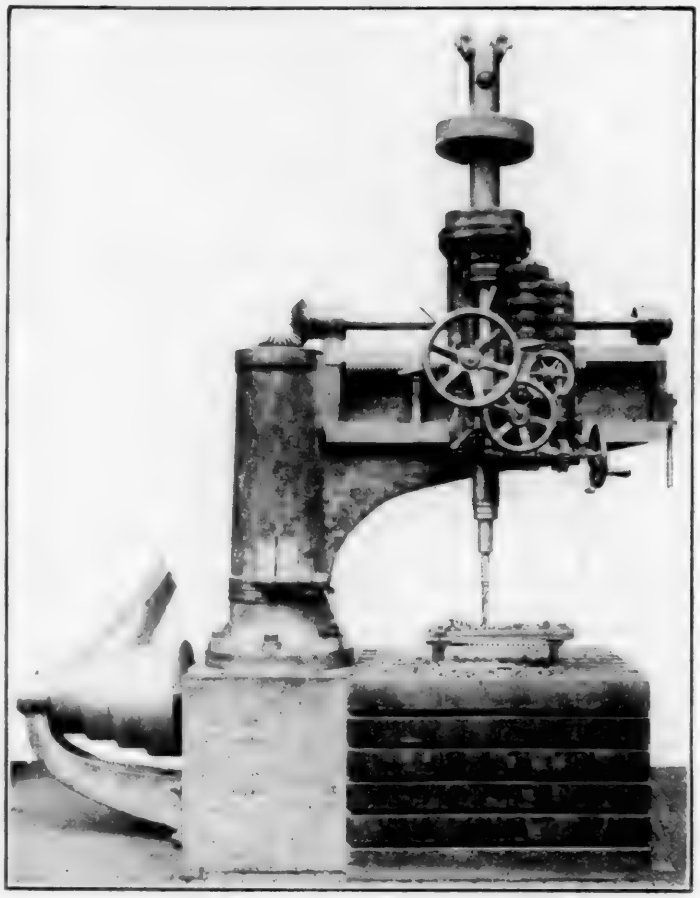

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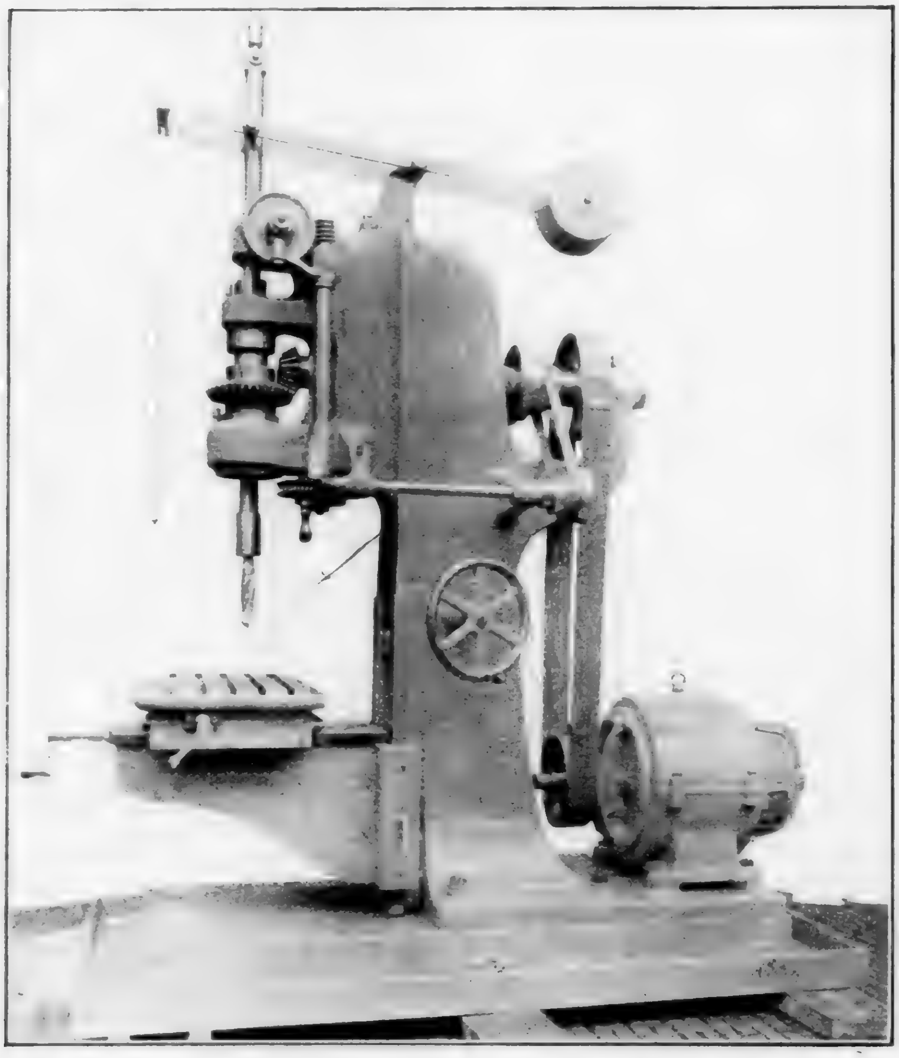

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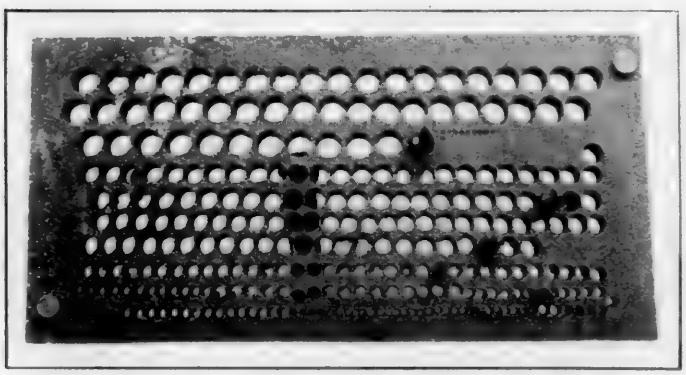

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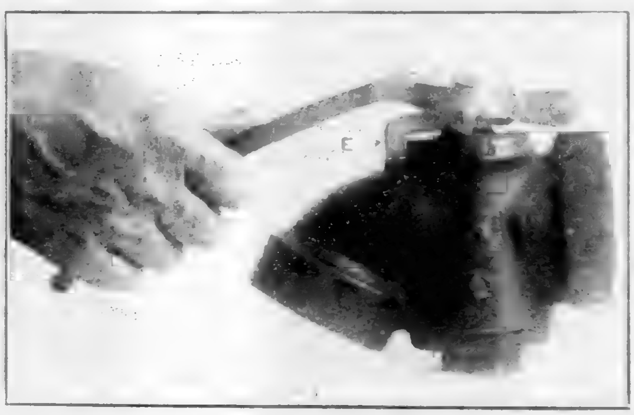

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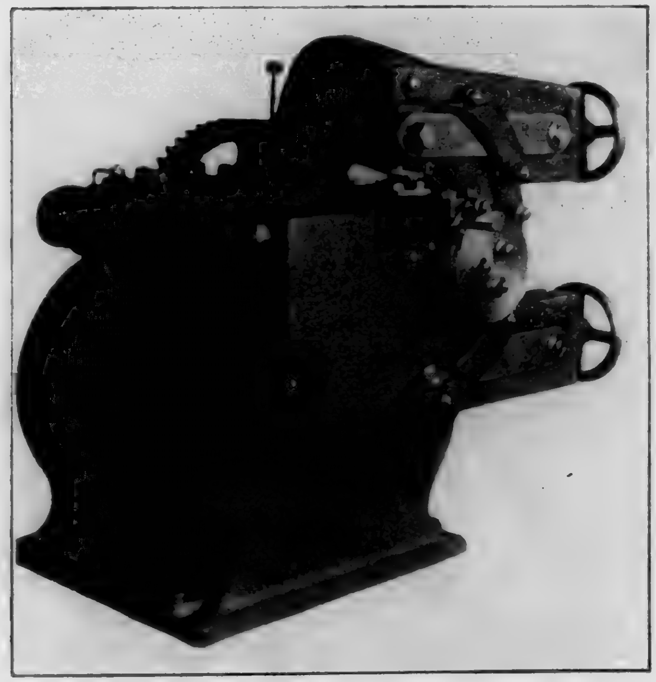
open, which prevents it from being moved beyond this position. When in this position the handle of its own weight drops so that the lug A comes into contact with the stop B on the body of the valve. The handle has a recess which fits down over the lug E. When the handle is in an unlocked position, as shown in one of the views, it may be moved so that the lug E comes into contact with the stop B, thus closing the valve. The backs of the lug A and the stop B are beveled so that when in this position the handle will drop into its normal position, but can readily be moved to the wide-open position.

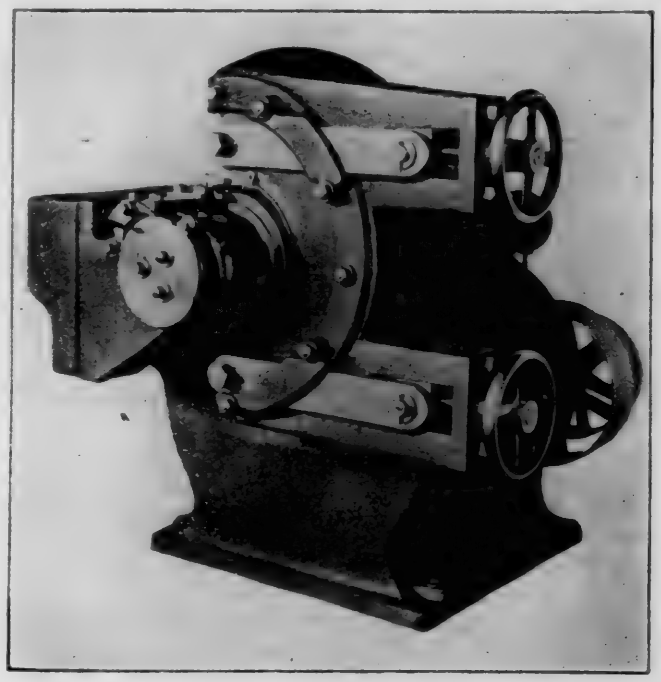
ACME THREAD ROLLING MACHINE.

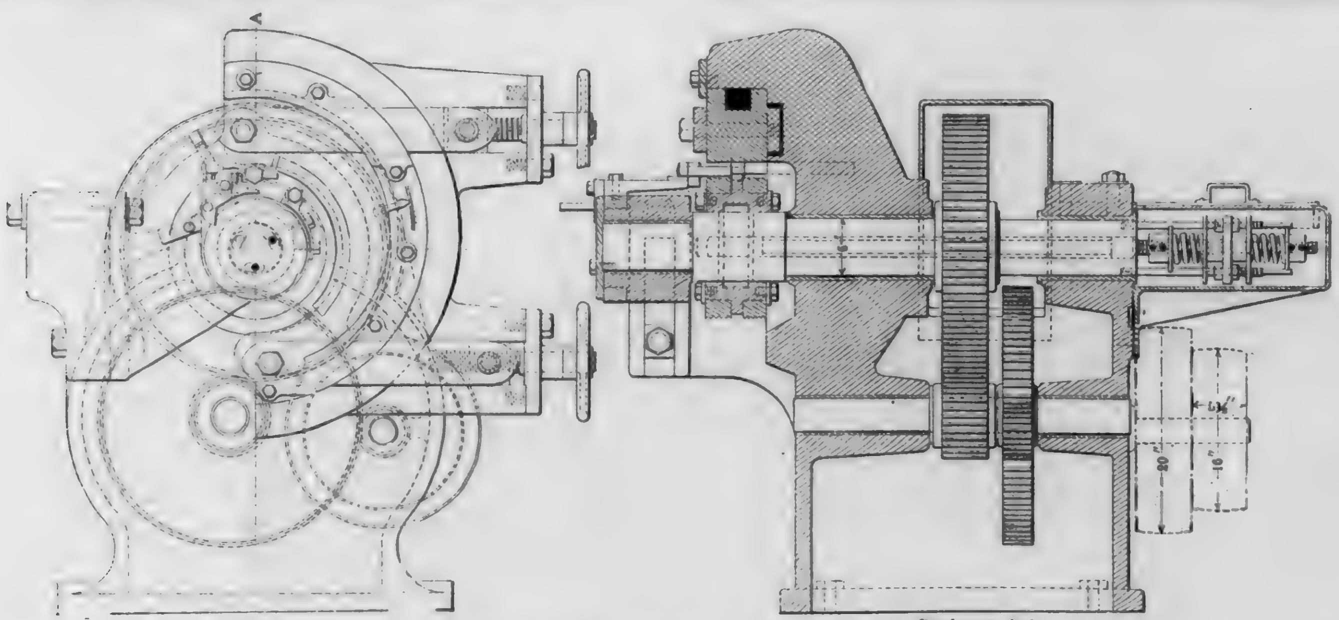
In this machine, made by the Acme Machinery Company, Cleveland, Ohio, the threading dies instead of being of the reciprocating type are composed of one rotary die which runs continuously in one direction and one segmental die which remains stationary after it has been adjusted to the bolt to be threaded. The bolt, or piece that is to have the thread rolled on it, is passed between the two dies and is carried around by the rotating die which is mounted on the main spindle.

The distance between the dies is adjusted by means of the two handwheels shown in the accompanying engravings. The segmental die is carried on a heavy block that is eccentric to the shaft and by loosening one of the handwheels and tightening the other the adjustable die is advanced or withdrawn from the rotary die. In the drawing, showing the die and feed mechanism, A is the rotary die, B the adjustable shoe or block carrying the segmental die and C is the driving spindle. A pointer on the frame and a scale on the segmental die holder indicate the degree of eccentricity and assist in the proper setting of the die. The bolt to be threaded, D, is first placed in the jaws E, then the operator starts the bolt into the machine by moving a handle—extending out from the feeding carriage—attached to the pawl F. This handle, shown in the photographs, drops the pawl into engagement with the notched disk G, which carries the oscillating carriage H forward and passes the work between the dies, the rolling beginning at once; the jaws then open automatically, allowing the carriage to drop back to the feeding position.

There are four opportunities for feeding in every rotation of the die, as there are four notches in the disk. The bolt or rod is fed into the machine horizontally so that bridge rods, car truss rods or other work of almost any length may have threads rolled on the end. It will be seen from the view show-



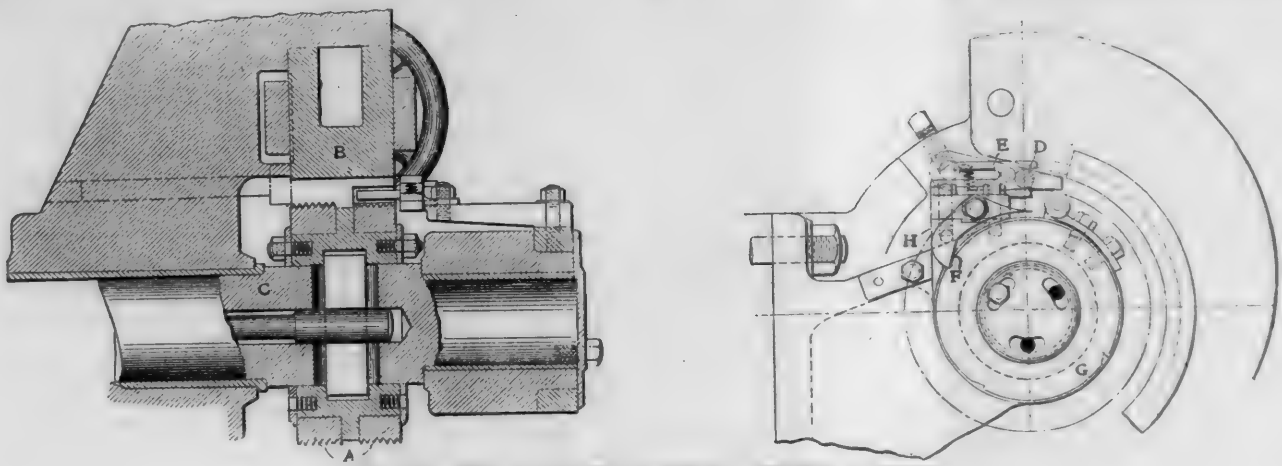




Front Elevation

Section on A-A

ACME THREAD ROLLING MACHINE.



DIE AND FEED MECHANISM—THREAD ROLLING MACHINE.

ing the elevation and section of the machine that at the rear end of the main spindle there are two spiral springs and means for putting them in tension. These keep the dies in pitch. As the bolt enters and the rolling begins at different points on the rotating die, the breaking down or the beginning of the thread is not confined to one particular place. The dies admit of fine adjustment for the required size of work, or to compensate for wear. The adjustment for different diameters with threads of the same pitch is made entirely by varying the setting of the stationary die. For other pitches a different set of dies may readily be substituted. Equipped with two sets of dies, as shown, the machine can be used for rolling studbolts, forming both ends at one operation.

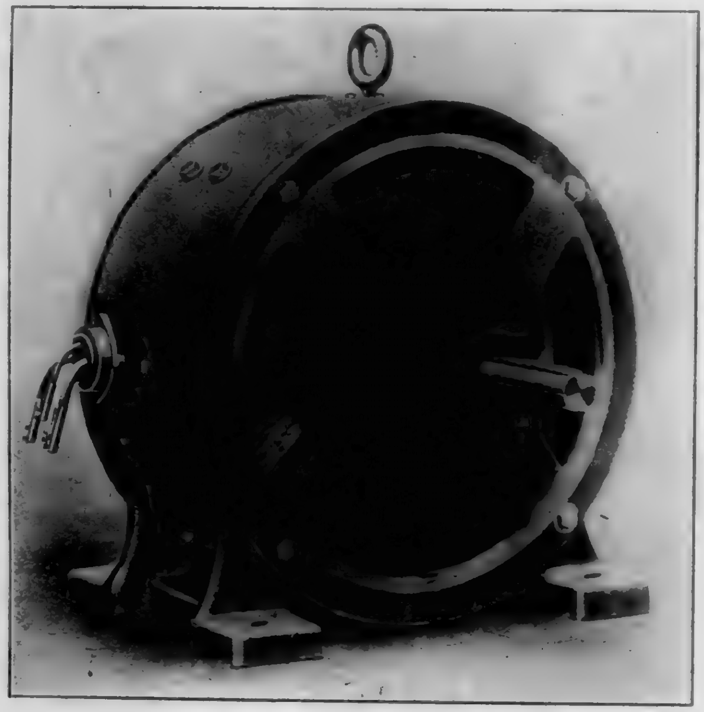
The following results of a recent test illustrate the comparative strength of cut and rolled threads, the material in both cases being machine steel. A 1¾ by 24⅝-in. bolt with cut thread showed a tensile strength of 88,900 lbs., while a 1½ by 24⅝-in. bolt with a rolled thread showed a tensile strength of 95,850 lbs. The rolled thread is, of course, not adaptable for every purpose, still the above test shows that where it may be used there is a considerable gain in strength and a consequent saving of weight and cost. A saving in time is also said to be effected, as at least twice as many bolts may be rolled as may be cut in the same time. These machines are made in two sizes, one rolling threads up to 1 in. in diameter and the other threads up to 2 ins.

WESTINGHOUSE AUXILIARY-POLE DIRECT CURRENT MOTOR.

Many classes of work require a wide speed variation, and to meet this demand the Westinghouse Electric & Manufacturing Company has developed a line of direct current motors, known as type SA, which by means of field control have a speed variation of 4 to 1 on a single voltage.

The new motors are similar mechanically and electrically to the Westinghouse type S motors, except for the addition of auxiliary poles and coils. These are introduced in order to control the field form during the variation of field strength necessary to obtain so wide a range of speed. The cast steel poles with machine-formed coils are placed midway between the main poles and securely bolted to the frame. The construction is very simple, and introduces no complications, nor does it make difficult the removal of the main poles and field coils, as is evidenced by the fact that an auxiliary pole and coil can easily be taken out, without in any way disturbing the main field winding, by simply disconnecting the coil connections, withdrawing the bolts which hold the pole to the frame and sliding the pole and coil out parallel to the shaft.

The auxiliary field winding is connected in series with the armature and produces a magnetizing effect which is proportional to the armature current. The auxiliary coils are placed as close to the armature surface as mechanical considerations will permit, and their turns are concentrated at that point. This arrangement adds materially to the performance of the motor, as it applies the corrective influences of the auxiliary winding at the points where the distorting effect of the armature current is strongest. This arrangement is much more effective than where the ampere turns are distributed along the length of the auxiliary poles. The magnetic field of the auxiliary winding acts in direct opposition to that produced by the armature current. The resultant field is made up of three components—that due to the shunt winding, that due to armature reaction, and that due to the auxiliary windings. The field distortion usually produced by armature reaction is therefore overcome, and the shape of the


AUXILIARY-POLE DIRECT CURRENT MOTOR.

magnetic field at the point of commutation is maintained as formed by the main poles, and good commutation is made possible over a wide range of speed.

Type SA motors are shunt wound, and thus have a definite speed for each point of the controller which is nearly constant for all loads. Heavy overloads may be momentarily developed without injurious sparking. The motors are reversible without danger and without readjustment of the brushes. As the armature and auxiliary windings are connected permanently in series, it is only necessary to change the external armature connections to reverse the direction of rotation. These motors develop their full rated output throughout the entire range of speed. They will carry full

rated load at any speed within their range for six hours with a temperature rise not exceeding 40 deg. C. in armature and field, and not exceeding 45 deg. C. on the commutator, as measured by thermometer. At all loads and all speeds commutation is excellent, and an overload of 25 per cent. may be carried for one hour without injurious sparking. Their efficiency is high and their speed regulation practically exact. With the exceptions noted, type SA motors are mechanically identical with the type S, and corresponding parts are interchangeable.

TESTS OF HIGH SPEED TOOL STEEL ON CAST IRON.

During the past year the engineering experimental station of the University of Illinois has been carrying on an extensive series of tests with high-speed tool steels, cutting cast iron, to determine the variation of the cutting force with the area of the cut; the variation of the durability of the tool with the cutting speed and the variation of the advisable cutting speed with the hardness of the iron. The following summary of results is taken from a bulletin issued by the University of Illinois and prepared by Professor L. P. Breckenridge and Mr. Henry B. Dirks.

The horse power lost in driving the lathe and countershaft was deducted from the total horse power used during the trial, the difference being the net horse power required for cutting. This was reduced to foot-pounds per minute, and divided by the cutting speed, giving the force exerted. The figures so obtained were reduced to pounds per unit area of cut, and plotted as ordinates upon a base of area of cut in Fig. 1. The curves show that the cutting force was not directly proportional to the area of cut, but decreased as the area increased, and that the average cutting force varied from 50 tons per square inch for soft iron to 85 tons per square inch for hard cast iron. Each curve shown in the figure represents a different hardness of cast iron. The relative hardness is shown in the table on the figure.

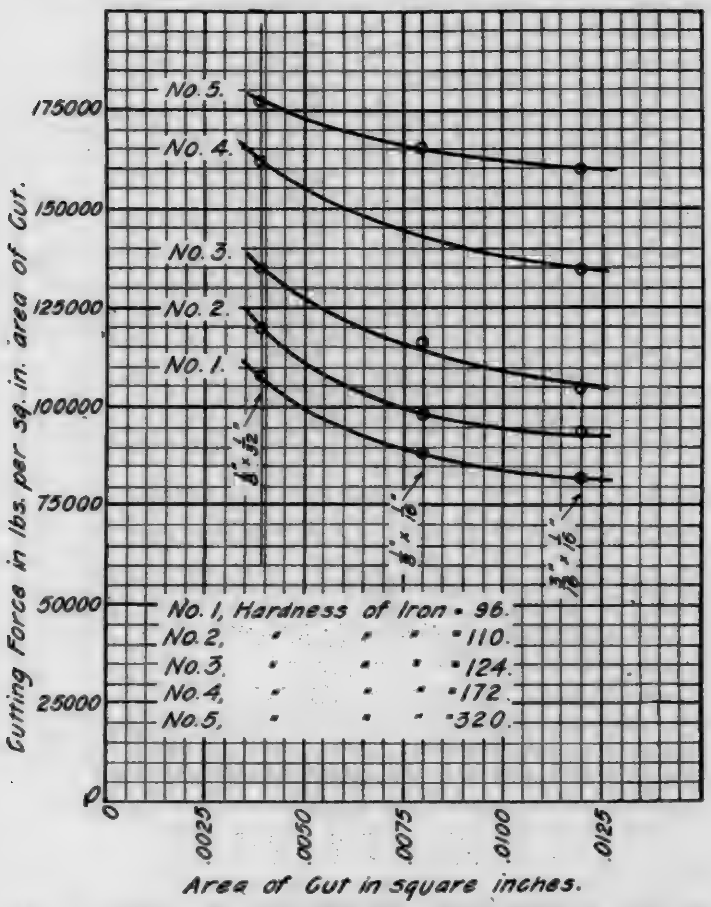


FIG. 1.—SHOWING RELATION BETWEEN CUTTING FORCE ON POINT OF TOOL AND AREA OF CUT FOR CAST IRON OF VARYING HARDNESS.

In Fig. 2 are shown the curves which represent the relation between the durability of the tool and the cutting speed. These are important curves. Each one represents a different hardness of cast iron. Referring to the middle curve, which is for cast iron of medium hardness, it will be seen that a cutting speed of 50 ft. per minute is satisfactory, the durability being 100. If the speed is increased very materially, the durability decreases quite rapidly. It is evident that for each hardness of cast iron the cutting speed allowable for a maximum durability exists where the vertical line indicating cutting speed is tangent to curves similar to those drawn.

The curve shown in Fig. 3 represents the advisable cutting speed on cast iron of varying hardness. This curve represents the result of all the tests of the different steels tested. It shows: (a) that any of the steels can remove very hard cast iron at a rate of 25 ft. per minute; (b) that all of the steels tested begin to wear rapidly at speeds a little above 125 ft. per minute. Between these two points the relation between a safe cutting speed and the hardness of the cast iron seems to be definitely expressed by the curve. It would seem that cast iron of medium hardness, 100 to 120, could be cut at 125 feet per minute just as readily as at 70 ft. per minute, as far as any injury to the tool is concerned. It must be re-

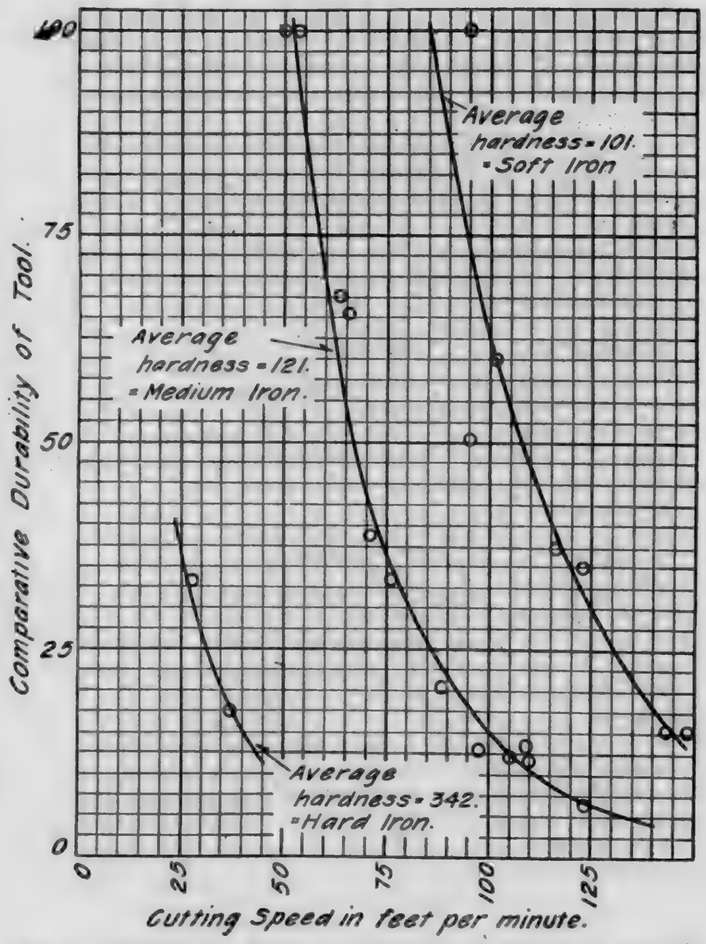
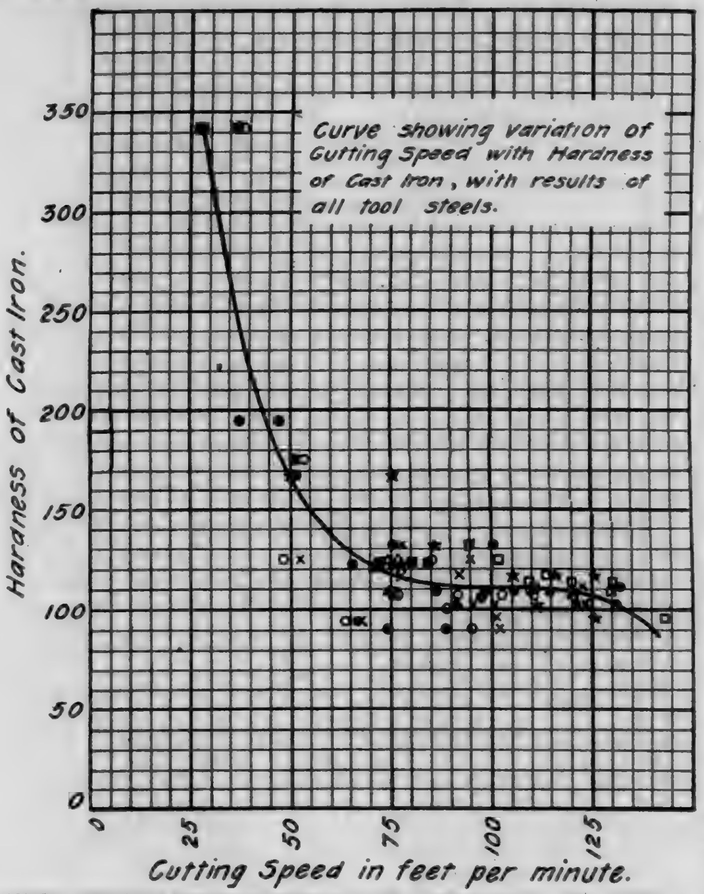


FIG. 2.—SHOWING VARIATION OF DURABILITY OF TOOL WITH CUTTING SPEED FOR CAST IRON OF VARYING HARDNESS.

membered that this curve does not take into account the effect, on the cutting speed, of the variation in the area of the cut; the experiments from which the curve was plotted were in all cases those in which the cut was very nearly ⅛ in. deep by 1-16 in. feed, so that there is but a slight variation in the area of cut in all of the experiments. In order that any company may make use of the curve shown in this figure, it will be necessary simply to determine the average hardness of its cast iron, as explained elsewhere, and where the horizontal line representing this hardness cuts the curve, the possible safe cutting speed may be read on the scale below. This curve should prove useful to manufacturers.

General speaking, all the steels tested proved equally effective. It is very evident that there are great possibilities ahead for high-speed steels. Before realizing their full bene-



CURVE SHOWING CUTTING SPEEDS IT IS ADVISABLE TO USE WITH A VARIATION IN THE HARDNESS OF CAST IRON.

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MODERN MACHINE TOOLS AND RAILROAD SHOP WORK.—The machine of to-day, aside from its inherent strength, is equipped with speed and feed adjustment attachments which are immensely valuable. These are no uncertain improvements tending to increased ease, accuracy and speed of output. I do not question the need of strength in the machine itself, but I do question the value of the results we get from a blind use of these machines. To be sure, if there is an excessive amount of stock to be removed from any piece to be finished, the rational method is to crowd on power and get it off, but my contention is this: In the average run of railroad machine shop work the excessive stock for finishing should not be there. Excessive stock means unnecessary initial expense for castings or forgings. Excessive stock on castings indicates poor pattern design or the use of one pattern to fill several sizes needed at a consequent saving in pattern shop labor, but a heavy increase in resultant net cost of output.—*Mr. C. J. Crowley, Western Railway Club.*

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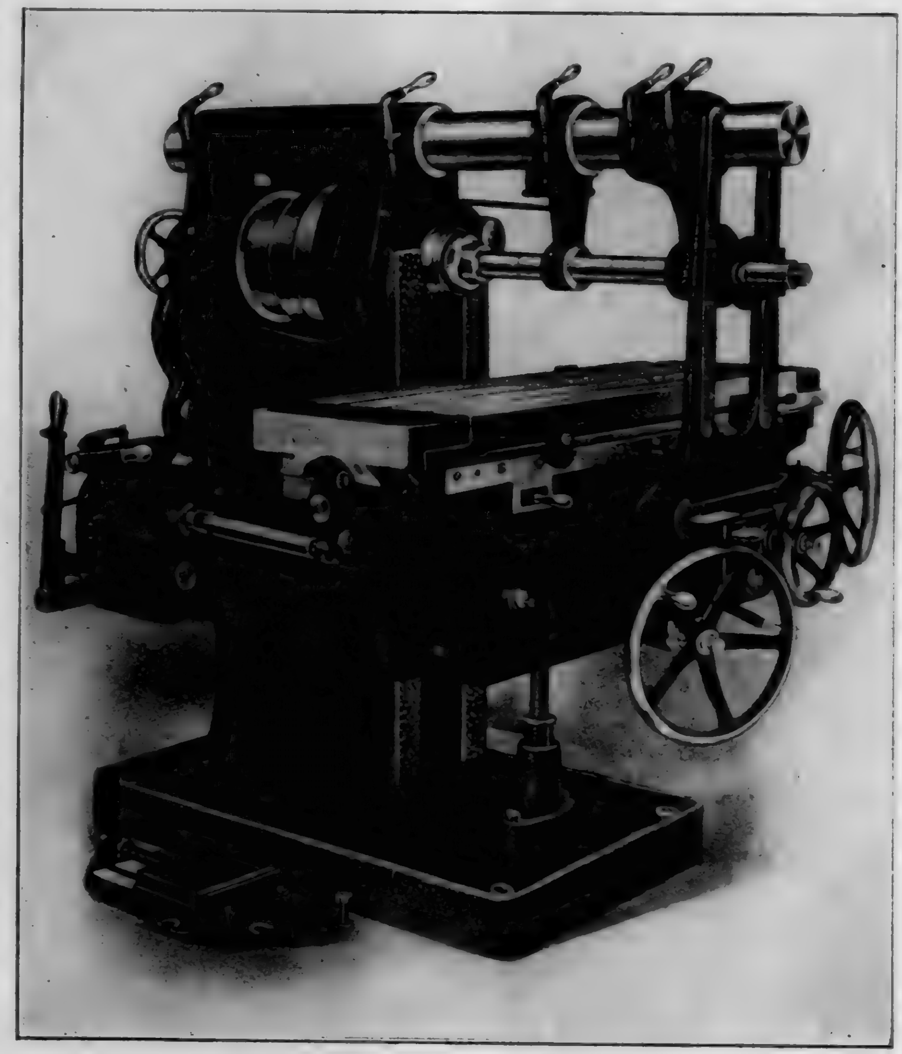
The Becker-Brainard No. 4 plain milling machine with gear feed, illustrated herewith, has, among other important new features, a positive gear feed drive and change feed mechanism, by which 20 changes of feed may be made without stopping the machine; also a new clutch mechanism in connection with the hand wheels, which prevents any accidental change from their fixed positions, and also prevents them from revolving when the automatic feeds are thrown in; the knee is of the box type, and is equipped with a telescopic elevating screw. The spindle, which is made from hammered crucible steel, has a ¾-in. hole through its entire length, and runs in self-centering bronze boxes arranged to compensate for wear. It has a slot across the end to engage the clutch on the arbor, and is threaded to take a chuck, a threaded collar covering the screw when not in use. The spindle is double back geared, the gears being protected by guards. The driving cone has three steps, and this in addition to the double back gears furnishes 18 different spindle speeds having a range of from 18 to 220 r.p.m.

The patented change feed mechanism is connected with the spindle by three spur gears. It is arranged on the back of the column, as shown, and by a simple movement of the levers any one of 20 changes of feed, ranging from .008 ins. to .366 ins. per revolution of the spindle, may instantly be obtained without stopping the machine. The overhanging arm is of steel 5 ins. in diameter, may be adjusted horizontally, and has an arbor support, which may be removed so that any of the attachments may be placed in position without removing the arm. The distance from the center of the spindle to this arm is 8¼ ins. The table has a working surface of 16½ by 48 ins.; has a longitudinal feed of 46 ins. and a power cross feed of 14 ins. The feeds may be reversed from the front of the



BECKER-BRAINARD MILLING MACHINE.

rated load at any speed within their range for six hours with a temperature rise not exceeding 40 deg. C. in armature and field, and not exceeding 45 deg. C. on the commutator, as measured by thermometer. At all loads and all speeds commutation is excellent, and an overload of 25 per cent. may be carried for one hour without injurious sparking. Their efficiency is high and their speed regulation practically exact. With the exceptions noted, type SA motors are mechanically identical with the type S, and corresponding parts are interchangeable.

TESTS OF HIGH SPEED TOOL STEEL ON CAST IRON.

During the past year the engineering experimental station of the University of Illinois has been carrying on an extensive series of tests with high-speed tool steels, cutting cast iron, to determine the variation of the cutting force with the area of the cut; the variation of the durability of the tool with the cutting speed and the variation of the advisable cutting speed with the hardness of the iron. The following summary of results is taken from a bulletin issued by the University of Illinois and prepared by Professor L. P. Breckenridge and Mr. Henry B. Dirks.

The horse power lost in driving the lathe and countershaft

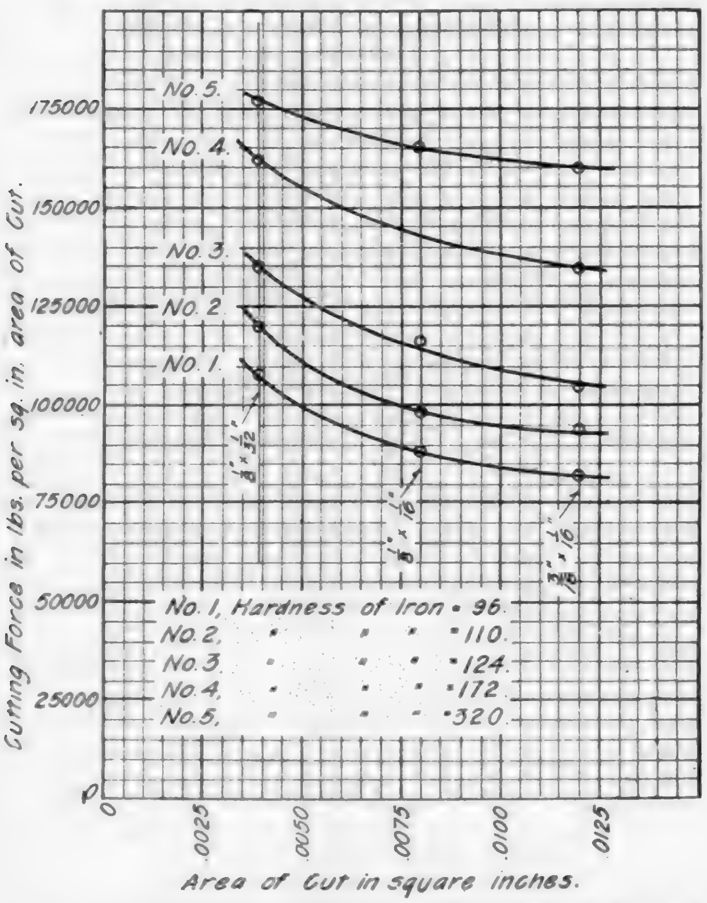


FIG. 1.—SHOWING RELATION BETWEEN CUTTING FORCE ON POINT OF TOOL AND AREA OF CUT FOR CAST IRON OF VARYING HARDNESS.

was deducted from the total horse power used during the trial, the difference being the net horse power required for cutting. This was reduced to foot-pounds per minute, and divided by the cutting speed, giving the force exerted. The figures so obtained were reduced to pounds per unit area of cut, and plotted as ordinates upon a base of area of cut in Fig. 1. The curves show that the cutting force was not directly proportional to the area of cut, but decreased as the area increased, and that the average cutting force varied from 50 tons per square inch for soft iron to 85 tons per square inch for hard cast iron. Each curve shown in the figure represents a different hardness of cast iron. The relative hardness is shown in the table on the figure.

In Fig. 2 are shown the curves which represent the relation between the durability of the tool and the cutting speed. These are important curves. Each one represents a different hardness of cast iron. Referring to the middle curve, which is for cast iron of medium hardness, it will be seen that a cutting speed of 50 ft. per minute is satisfactory, the durability being 100. If the speed is increased very materially, the durability decreases quite rapidly. It is evident that for each hardness of cast iron the cutting speed allowable for a maximum durability exists where the vertical line indicating cutting speed is tangent to curves similar to those drawn.

The curve shown in Fig. 3 represents the advisable cutting speed on cast iron of varying hardness. This curve represents the result of all the tests of the different steels tested. It shows: (a) that any of the steels can remove very hard cast iron at a rate of 25 ft. per minute; (b) that all of the steels tested begin to wear rapidly at speeds a little above 125 ft. per minute. Between these two points the relation between a safe cutting speed and the hardness of the cast iron seems to be definitely expressed by the curve. It would seem that cast iron of medium hardness, 100 to 120, could be cut at 125 feet per minute just as readily as at 70 ft. per minute, as far as any injury to the tool is concerned. It must be re-

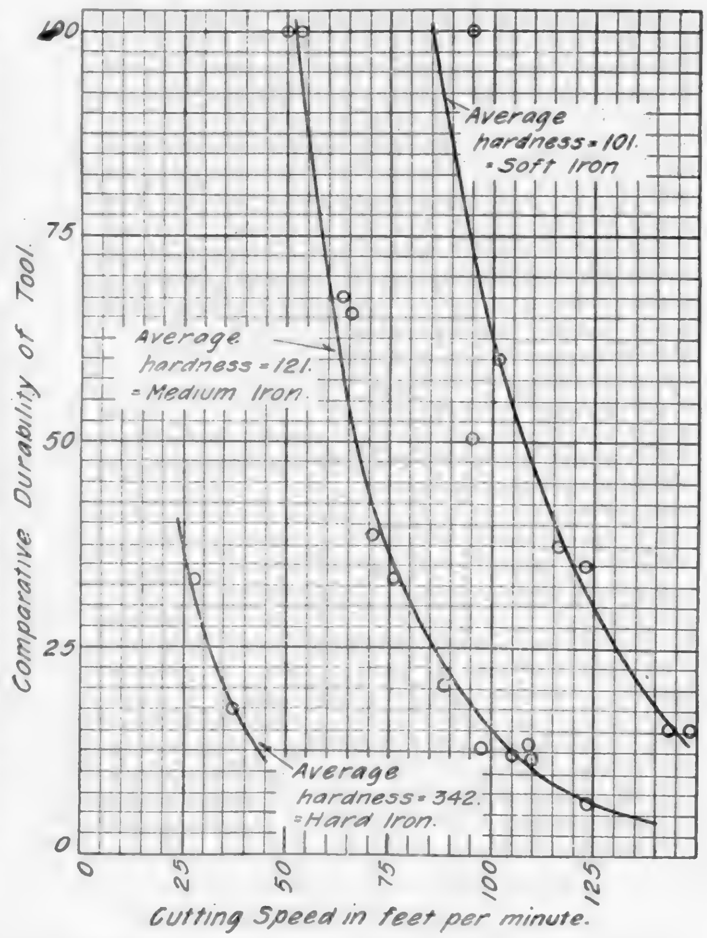
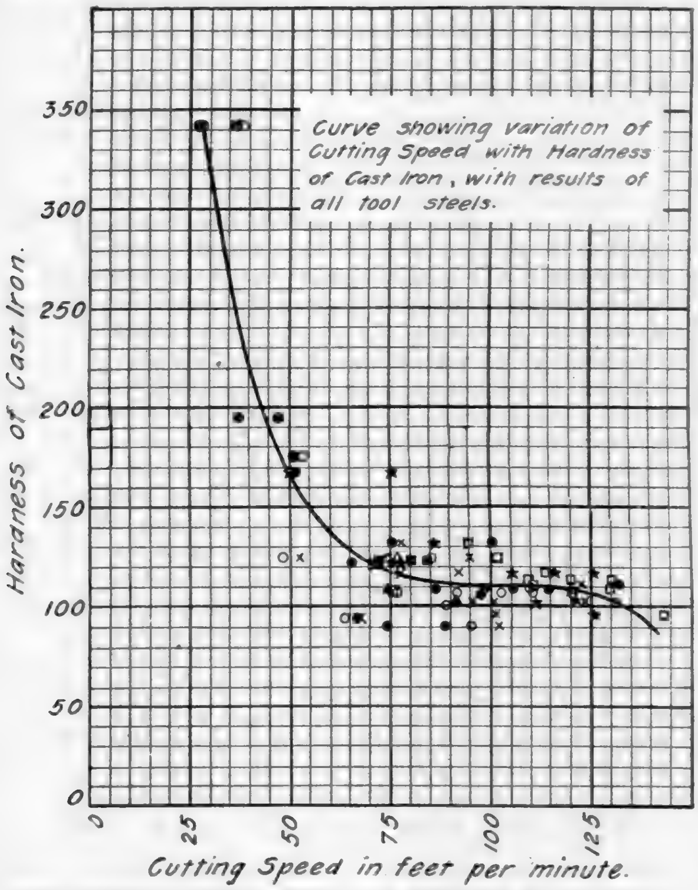


FIG. 2.—SHOWING VARIATION OF DURABILITY OF TOOL WITH CUTTING SPEED FOR CAST IRON OF VARYING HARDNESS.

membered that this curve does not take into account the effect, on the cutting speed, of the variation in the area of the cut; the experiments from which the curve was plotted were in all cases those in which the cut was very nearly ⅛ in. deep by 1-16 in. feed, so that there is but a slight variation in the area of cut in all of the experiments. In order that any company may make use of the curve shown in this figure, it will be necessary simply to determine the average hardness of its cast iron, as explained elsewhere, and where the horizontal line representing this hardness cuts the curve, the possible safe cutting speed may be read on the scale below. This curve should prove useful to manufacturers.

General speaking, all the steels tested proved equally effective. It is very evident that there are great possibilities ahead for high-speed steels. Before realizing their full bene-



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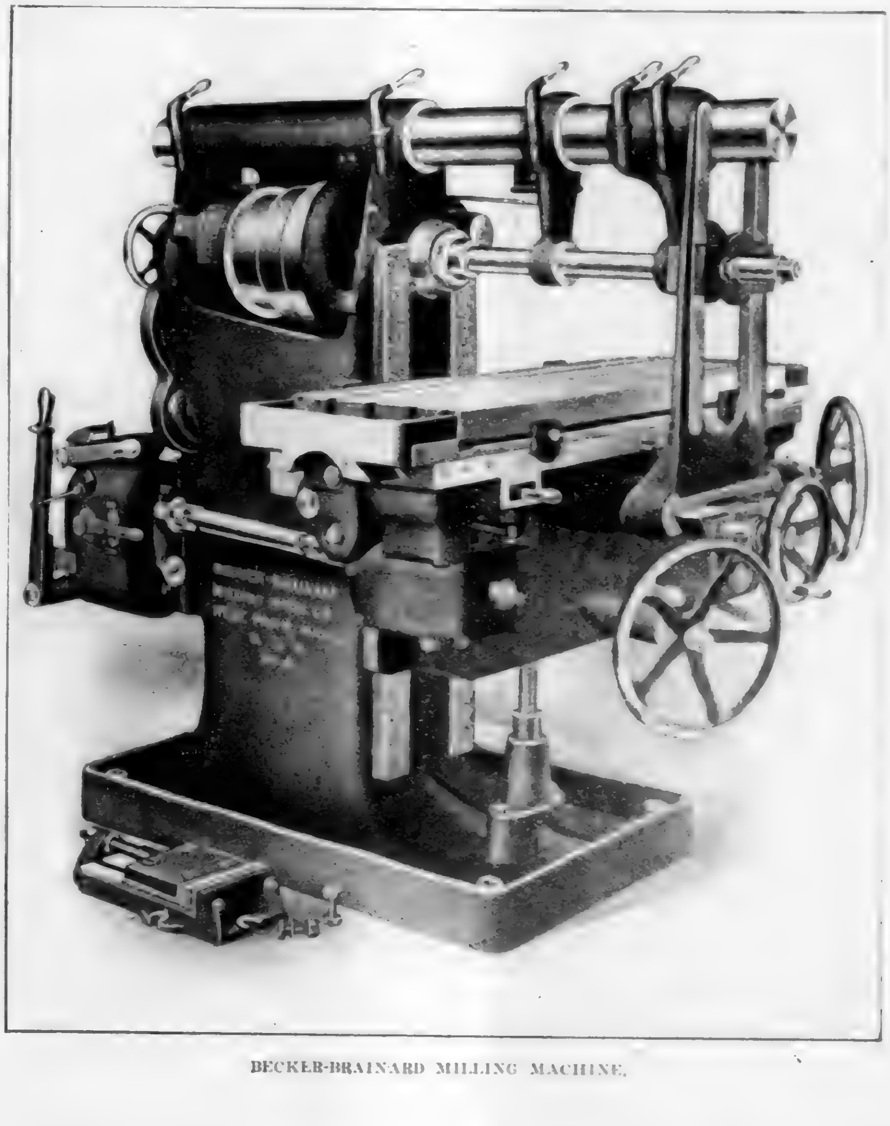

BECKER-BRAINARD MILLING MACHINE.

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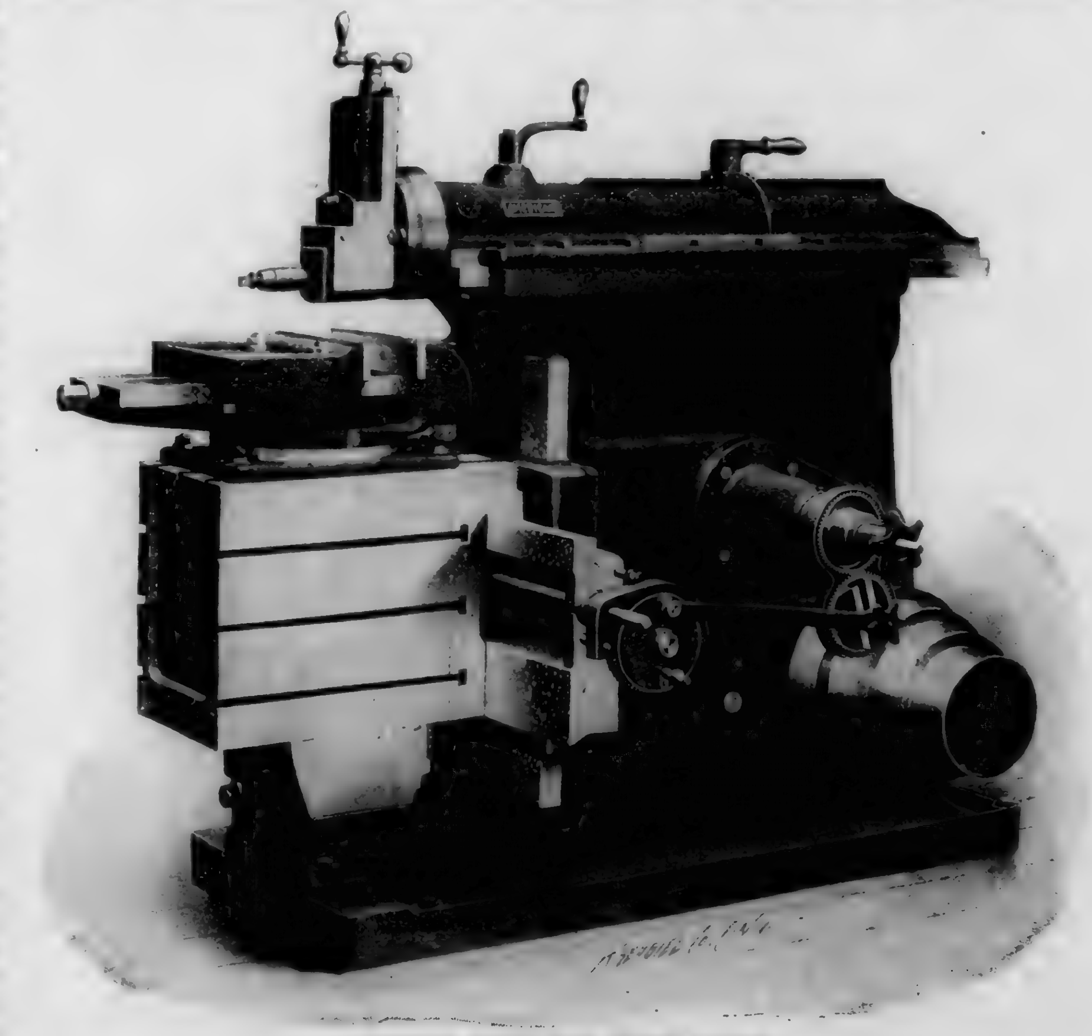
The clutch arrangement, which is provided with the hand wheels for operating the feeds, is enclosed in a hub. When the table has been set to the required position the clutch may instantly be disengaged by pressing in the knob on the front of the handwheels. Dials, which are adjustable and are graduated to read to thousandths of an inch to indicate the vertical, transverse and the longitudinal movements of the platen, are set in position with a set screw. The net weight of the machine is 7,100 lbs.

HEAVY BACK GEARED SHAPER.

The American Tool Works Company of Cincinnati is getting out a new line of extra heavy and powerful shapers ranging in size from a 16 to a 28-in. stroke. The general design of these machines is similar to that of the 28-in. shaper shown in the illustration. In a recent test one of these machines took a cut in cast iron ½-in. deep, 5-32-in. feed, with the highest speed of the back gears and the belt running on the smallest step of the cone pulley; under similar conditions a cut ½ in. deep, 5-64 in. feed, was taken in tough machine steel.

The column is deep and wide, tapers slightly toward the top and is strongly braced internally. On the outside the column is reinforced by a wide, deep rib, and is extended at the top to both the front and the rear, to provide a long bearing for the ram. The ram is designed for uniform strength at all points of the stroke, and has eight changes of speed ranging from 15 to 181½ ft. per minute with the machine running full stroke. The stroke may be adjusted while the machine is in motion. The rocker arm is pivoted near the base line, giving the ram an almost uniform rate of speed for its entire stroke and providing a very quick return. Change may be made from single to back gears by means of a convenient lever. The back gear ratio is 1 to 29.4, and the maximum length of stroke is 28½ ins. The rocker arm is bifurcated at the top, and this, with the opening through the column, provides for the key seating of shafts up to 3½ ins. in diameter. The head swivels to an angle of 50 deg. on either side of the vertical and has an improved locking device. The down feed has a traverse of 9 ins., and the feed screw has an adjustable graduated collar reading to .001 in. The table is fitted to the apron by an improved method, insuring accuracy and stiffness, and is detachable. The vertical travel of the table is 13¾ ins., the horizontal travel is 31 ins. The telescopic elevating screw has ball bearings. The cross feed is variable and automatic, having a range of .0114 to .25 in. The feed may be reversed without stopping the machine.



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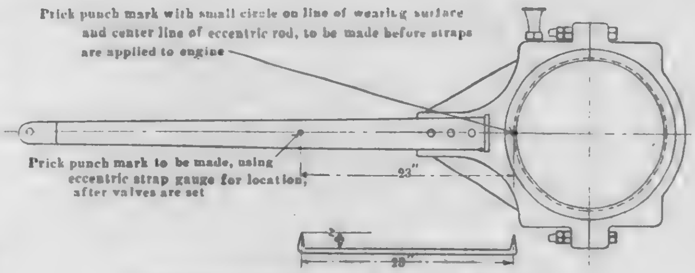

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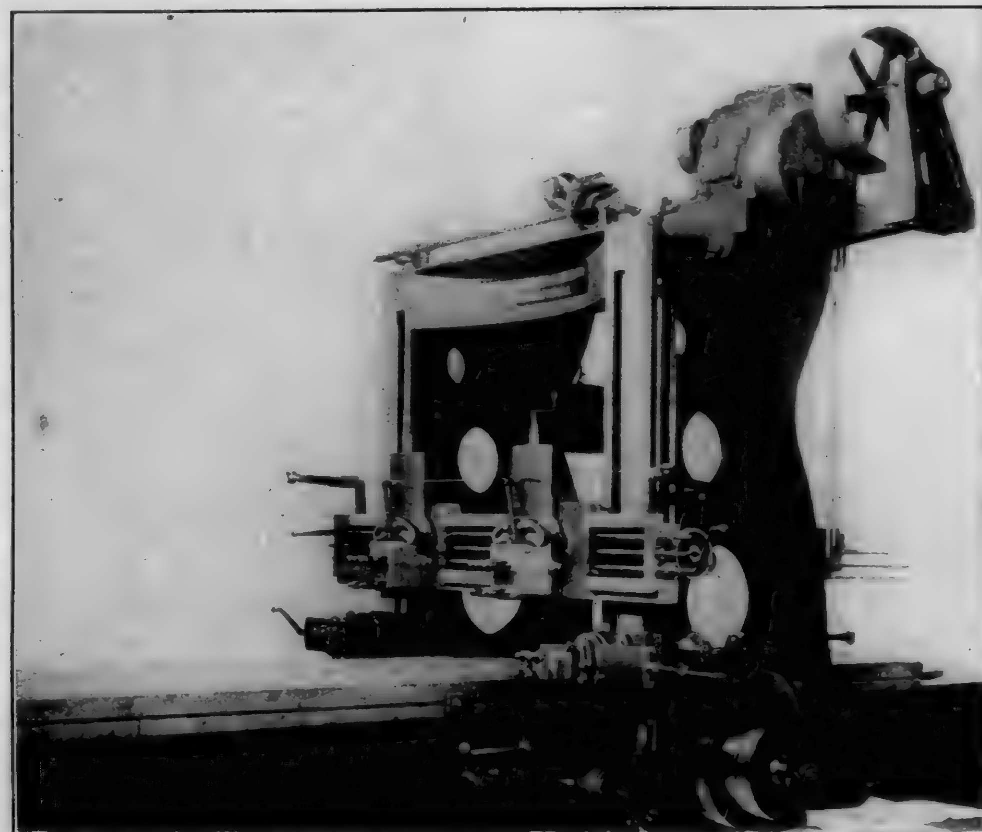
72-INCH IMPROVED CINCINNATI PLANER.

The Cincinnati Planer Company recently furnished the Trenton, N. J., shops of the Pennsylvania Railroad with one of their standard 72 by 72-in. by 18-ft. planers, equipped with four heads, a variable speed box, an automatic tool lifting device and arranged for a motor drive. The speed box is arranged for six cutting speeds (20, 25, 30, 35, 40 and 45 ft. per minute), and a constant return speed. The planer is driven by a 30-h.p. Westinghouse motor (not in place when the photograph was taken), which is mounted above the housings in the same manner as the application to the 42-in. forge planer shown on page 303 of the August, 1905, issue.

The bed of the machine is made of extra length, so that there is very little overhang of the table when planing at full stroke. The table is very deep, is thoroughly ribbed underneath and has a complete shifting mechanism on each side. The housings are carried down to the floor and in addition to being fastened by the usual bolts and dowel pins are secured by a long tongue and groove. The heads are of a new shape, the end of the tool block and slide being made round to avoid projecting corners on angular work. The slides are hung on ball bearings. The side heads have an independent power and hand vertical feed, and may be run below the top of the table when not in use. The handles, which control the feeds for these heads, travel up and down with them and are always convenient to the operator.



IMPROVED 72-INCH CINCINNATI PLANER.

The cross rail, as may be seen, has a very long bearing on the housing, and is strengthened by an arch-shaped brace at the back. The cross rail is raised and lowered by means of a patent device, which was described on page 194 of our May, 1904, journal. It is located in the center of the arch, thus providing a third bearing for the elevating shaft and distributing the pull equally. The shifter is provided with a safety locking device, which prevents the table from starting except at the will of the operator. The rear dog is fitted with a latch so that when desired the table may be run from under the cutting tool.

MOTOR-DRIVEN BENDING ROLLS.

The accompanying illustration shows a large Bement, Miles & Company No. 7 plate bending machine, which is driven by a 20-h.p. semi-enclosed Crocker-Wheeler motor. The lower rolls are 11 inches in diameter, have a central bearing, and are driven positively through gearing in either direction. The motor is so designed as to meet the heavy strains incident to this class of work, and although it is partially enclosed for the protection of vital parts it has sufficient openings to provide for good ventilation and access to the internal parts. The upper roll of the machine is 16½ inches in diameter, and is extended to receive the pressure of a screw bearing which supports the roll when the jointed bearing at the other end is removed to allow a circle or flue to be taken off. The lower rolls are stationary, and the two ends of the top roll have a vertical adjustment, either individually or together, through worm gearing and screws actuated by a 15-h.p. Crocker-Wheeler motor. This motor is reversible, and runs at a constant speed. It is supplied with current at 240 volts, while the motor which revolves the lower rolls is supplied from a four-wire multiple voltage system. These

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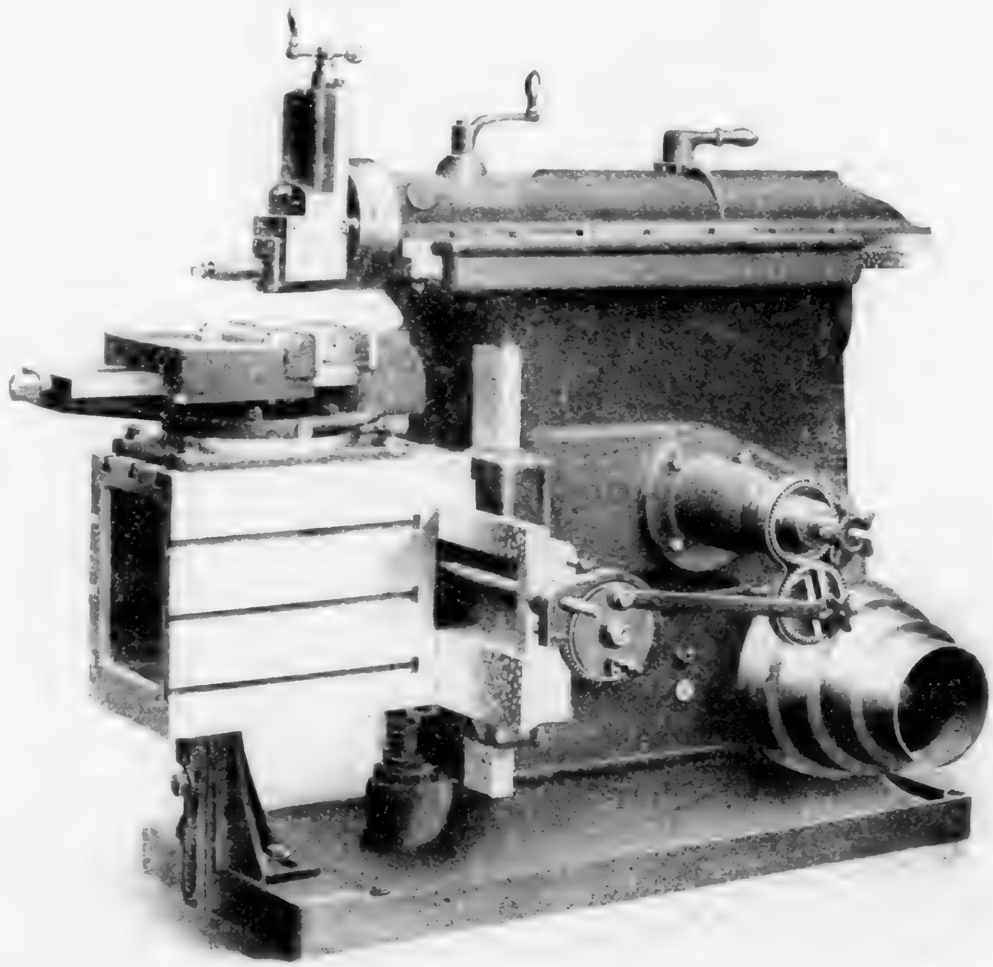

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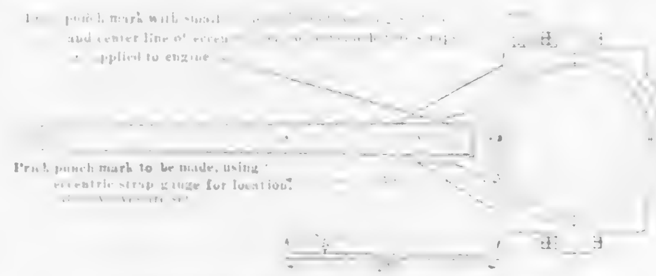

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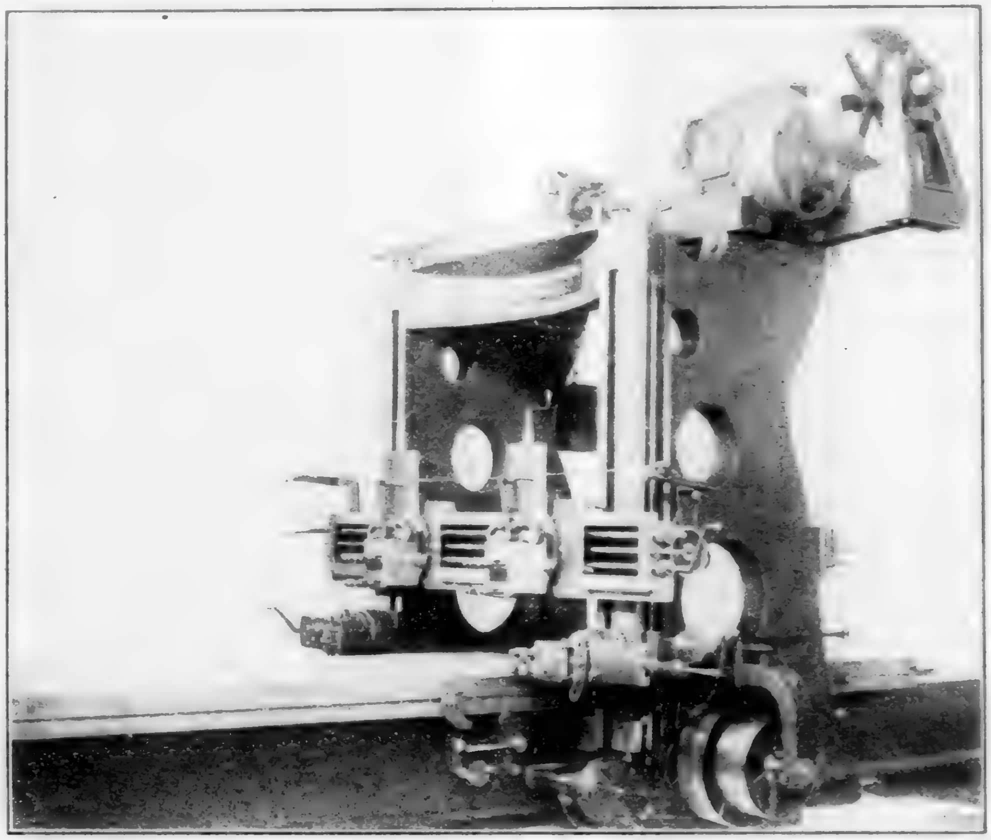

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MOTOR DRIVEN BENDING ROLLS.

bending rolls measure 12 ft. 2 in. between the housings, and will handle 7/8-in. plates.

MR. WALDO H. MARSHALL.

Mr. Waldo H. Marshall has resigned the position of general manager of the Lake Shore & Michigan Southern Railway, to accept the presidency of the American Locomotive Company. Mr. Marshall served an apprenticeship with the Rhode Island Locomotive Works, after which he entered the drafting room, and soon became chief draftsman. Later he spent some time in New York as consulting mechanical engineer. In January, 1888, he went to Chicago as editor of the *Railway Review*. Three years later he became editor of the *Railway Master Mechanic*. During 1896 and the early part of 1897 he edited the AMERICAN ENGINEER AND RAILROAD JOURNAL with Mr. M. N. Forney. In June, 1897, he was appointed assistant superintendent of motive power of the Chicago & Northwestern. Two years later he was called to the position of superintendent of motive power of the Lake Shore & Michigan Southern Railway. From February, 1902, to July, 1903, he was general superintendent of the same road, also of the Lake Erie & Western and the Indiana, Illinois and Iowa. Since July, 1903, he has been general manager of these roads. From apprentice in a small locomotive works to the presidency of the largest locomotive company, although Mr. Marshall is not yet 42 years of age, is indeed a remarkable rise. His thorough technical education is the result of individual study. His success is probably in large measure due to honesty, personal ability, breadth of view and to the fact that he has the faculty of being able to develop and surround himself with capable and loyal subordinates.

PERSONALS.

Mr. J. R. Alexander has been appointed general road foreman of engines of the Pennsylvania Railroad at Altoona, Pa.

Mr. W. J. Rusling has been appointed assistant to the assistant engineer of motive power at Altoona, Pa.

Mr. William Elmer, Jr., assistant engineer of motive power at Altoona, has been appointed master mechanic of the Pittsburgh shops, to succeed Mr. Thomas.

Mr. W. B. Ott, assistant engineer of motive power at Buffalo, N. Y., has been transferred to Altoona, Pa., in a similar capacity, succeeding Mr. W. Elmer, Jr., promoted.

Mr. S. G. Thomson has been appointed assistant engineer of motive power of the Buffalo & Allegheny Valley division of the Pennsylvania Railroad at Buffalo, N. Y., succeeding Mr. W. B. Ott, transferred.

Mr. I. B. Thomas, master mechanic of the Pittsburgh shops of the Pennsylvania Railroad, has been appointed master mechanic of the shops at Altoona, Pa., in place of Mr. G. W. Strattan, retired under the pension rules, having reached the age of 70 years.

Mr. M. J. McCarthy has been appointed division master mechanic of the Lake Shore & Michigan Southern Railway at Elkhart, Ind., succeeding Mr. Cross, transferred.

Mr. C. W. Cross, division master mechanic of the Lake Shore & Michigan Southern Railway at Elkhart, Ind., has been appointed to the newly created position of superintendent of apprentices, with headquarters at New York.

Mr. George Dickson has been appointed master mechanic of the Chicago, Cincinnati & Louisville Railroad, with office at Peru, Ind.

Mr. H. J. Beck, road foreman of engines of the Philadelphia & Reading Railway, has been appointed general locomotive inspector, with office at Reading, Pa.

Mr. G. G. Davis has been appointed general foreman of the car department of the Cleveland, Cincinnati, Chicago & St. Louis Railway, at Indianapolis, Ind.

Mr. L. L. Bentley has resigned as mechanical engineer of the Lehigh Valley Railroad to become vice-president and general manager of the Oswego Boiler & Engine Company, of Oswego, N. Y.

Mr. J. N. Mallory, formerly in the department of tests of the New York Central, has been appointed mechanical engineer of the Lehigh Valley Railroad, succeeding Mr. L. L. Bentley, resigned.

Mr. W. N. Cox, superintendent, has been appointed superintendent of transportation and machinery of the Atlanta & West Point Railway, with office at Montgomery, Ala. The office of superintendent has been abolished.

Mr. D. J. Malone, division master mechanic of the Oregon Short Line at Salt Lake City, Utah, has been appointed division master mechanic of the Southern Pacific Railway at Ogden, Utah, to succeed Mr. E. M. Luckett, resigned.

Mr. W. C. Smith, master mechanic of the Missouri Pacific Railway at Fort Scott, Kan., has been transferred to Kansas City, Mo., in a similar capacity, to succeed Mr. William Naughton, resigned.

Mr. M. J. McGraw, heretofore master mechanic of the Illinois Central Railway at Clinton, Ill., has been appointed master mechanic of the Missouri Pacific Railroad, at Fort Scott, Kan., succeeding Mr. W. C. Smith.

Mr. L. E. Hassner, heretofore general foreman of shops of the Illinois Central at East St. Louis, Ill., has been appointed master mechanic at Clinton, Ill., succeeding Mr. M. J. McGraw, resigned.

Mr. George W. Little, assistant treasurer of the Pittsburgh Spring & Steel Company, died on Friday, February 16th, of pneumonia, after an illness of one week. Mr. Little had a long experience in the spring business, having been originally connected, in the accounting department, with A. French & Company some thirty years ago, and continued with that company and its successors until 1902, when he became assistant treasurer of the Pittsburgh Spring & Steel Company, which position he held at the time of his death. His long experience in the spring business made him a valuable member of the company, and his death will be a great loss, not only to his immediate associates, but also to the community in which he was held in high esteem.

HEAVY TONNAGE OF STEEL FOR CARS.—From competent authority we have the estimate that between 1,300,000 and 1,400,000 tons of rolled and forged steel will be required for the steel car works output of 1906, and when to shapes and axles are added the requirements in foundry products—malleables, steel castings and car wheels—it may be reckoned that 1,800,000 to 1,900,000 tons of iron and steel will be consumed by this single industry in the present year, a source of demand that was scarcely regarded as a factor seven years ago. Already rapidly approaching the wire and wire nail industries in its requirements of iron and steel, the steel car industry is pushing forward at a rate that one day may bring its tonnage abreast of that entering into steel rails.—*The Iron Age.*

REAMING CORED HOLES VS. DRILLING.—Actual practice determines a hole can be properly reamed for one-half what it costs to drill; therefore, if a hole must needs be exact in location and size, first core it as large as practice will permit, then finish with a reamer.—*Mr. C. J. Crowley, Western Railway Club.*

BOOKS.

Locomotive Tests and Exhibits, Pennsylvania Railroad System, Louisiana Purchase Exhibition, 1904, 727 pages. Published by the Pennsylvania Railroad Co. D. S. Newhall, Purchasing Agent, Broad Street Station, Philadelphia, Pa. Price, $5.00.

An extended review of this book will be found on page 90 of this issue.

Foundations and Setting Machine Tools. Published under the direction of the engineering bureau of the Niles-Bement-Pond Company, 111 Broadway, New York.

This is a small pamphlet of 12 pages containing a number of important notes concerning the construction of foundations for machine tools and the setting of machines.

The Science Year Book. Edited by Major B. F. S. Baden-Powell. Published by King, Sell & Olding, Ltd., 27 Chancery Lane, W. C., London, England. Standard, 6 by 9 in. size. Price, 5s.

The first 208 pages are devoted to astronomical, physical and chemical notes and tables, to summaries of progress in science and to various directories, etc. The remainder of the book, about 375 pages, is reserved for a diary.

Master Car Builders' Association. Proceedings of the thirty-ninth annual convention held at Manhattan Beach, N. Y., June, 1905. Edited by the Secretary, Mr. J. W. Taylor, Old Colony Building, Chicago, Ill.

The association standards, recommended practice, interchange rules, reports of the arbitration committee and the convention proceedings, constitute a volume of 575 pages, and in addition there are a large number of folded plates used in connection with the committee reports and also showing the association standards.

Proceedings of the International Railroad Master Blacksmiths' Association. Thirteenth Annual Convention, held at Cleveland, August, 1905. Edited by A. L. Woodworth, Secretary, Lima, Ohio.

These proceedings are specially interesting and valuable and should be in the hands of all those interested in this work. Among the more important subjects considered were oil furnaces, treatment of high-speed steel, repairing locomotive frames, forging motion work, dies and formers for forging machines, tools and formers for steam hammers, and the ideal blacksmith shop.

Machine Shop Arithmetic. By Fred H. Colvin and Walter Lee Cheney. Fourth Edition. 1905. 144 pages; 4 by 6 ins. Flexible cover. Published by the Derry-Collard Company, 256 Broadway, New York. Price, fifty cents.

The fact that it was necessary to issue a 4th edition of this little work, indicates that it has met a real need. It considers problems which often come up in the machine shop, and not only are rules presented for their solution, but explanations are given in clear and simple language, as to why each step is taken. Additions to this edition include metric threads and tables for force and running fits.

Tests of High Speed Tool Steels on Cast Iron. By L. P. Breckenridge and Henry B. Dirks. Published by the University of Illinois Engineering Experimental Station, Urbana, Ill.

This is the second bulletin on high speed steels. The first one gave a brief account of the development of these steels, announced the series of tests to be made and presented tabulated results of the most important tests which had been made by various authorities. Bulletin No. 2 describes an extensive series of tests made at the engineering experiment station of the University of Illinois, during the past year, with the high speed tool steels cutting cast iron. The summary of results is very interesting and valuable and is partially reproduced on another page of this issue. The bulletin closes with a list of the leading articles which have been published on high speed steels. Copies of this bulletin may be obtained from the Engineering Experimental Station, Urbana, Ill.

Electric Wiring, Diagrams and Switchboards. By Newton Harrison. Published by the Norman W. Henley Publishing Company, 132 Nassau Street, New York. 1906. 272 pages, 105 illustrations. Price, $1.50.

This is a practical treatise on the theory and design of wiring circuits. It is well illustrated, and, although it is a technical work the underlying principles of wiring are presented in language suited to the comprehension of the general reader. The fundamental principles of wiring are first considered, and after their application to a simple circuit has been thoroughly presented the more complex types of circuits are carefully considered. Several chapters are devoted to moulding and conduit work. It also contains several chapters on the design of switchboards for lighting and power, and considerable space is devoted to the consideration of alternating current circuits. The calculations and examples in the treatment of both direct and alternating current are limited to the use of simple arithmetic.

Proceedings of the Railway Signal Association for the Year 1905. Volume 8. Published by the Association, 335 Madison Avenue, New York City. 360 pages. Price twenty-five cents.

This volume contains the individual papers, committee reports and discussion of the two New York meetings, two Chicago meetings, and the annual meeting held at Niagara Falls in October. Among the more important subjects considered were the use of the storage battery in connection with signals; signalling in the New York subway; standard specifications for mechanical interlocking and material for construction work (these standards were adopted at the October meeting); discipline of trainmen as relating to automatic block signals; the semaphore spectacle, the cost of stopping trains compared with the cost of maintenance, operation and inspection of interlocking plants; circuits for manual block signal system; organization of the signal department; copper-covered wire for signal purposes; circuits for automatic block signals for steam and electric roads; signal lamps, designs, oil used, care of, etc.; observations on signal lenses; the roundel problem; railway telephone service (cost of line construction).

Proceedings of the Traveling Engineers' Association. Thirteenth Annual Convention, held at Detroit, September, 1905. Edited by Mr. W. O. Thompson, Secretary, Oswego, N. Y. 328 pages.

This report is a very forcible indication of the flourishing condition of the association and should be in the hands of all those who are interested in locomotive operation and maintenance. It includes committee reports and discussions of the following subjects. Is the third man necessary on the large type of modern locomotives; if so, in what capacity? Grease as a lubricant for all bearings on a locomotive. What devices for and arrangement of engines and tenders will lighten the work of the engineer and firemen? Bell ringers, air sanders and other devices operated by compressed air; their care and arrangement to get the best results. The following individual papers were presented and discussed: Electric motors and instructing the men to handle them, by E. F. Miller. Injectors: modern practice, by S. L. Kneass. The latest makes of lubricators; their operation and maintenance, by C. B. Conger. The mechanical stoker, by C. A. Kraft. The piston versus the slide valve, by L. S. Allen.

Biographical Directory of Railway Officials of America. Published by the Railway Age Company of Chicago. Cloth bound. 694 pages; 6 by 8½ ins. 1906. Price, $3.00.

It is aimed to present in a concise form the history of the professional careers of the officials of American railroads. It is interesting to note that about 1,200 new sketches have been added which did not appear in the 1901 edition, and about the same number of names have been ommitted because of death, or retirement from the service. The new edition also contains sketches of the personal history of 96 national and state railroad commissioners. It is rather disappointing to find that the names of several important railway officials have been omitted, but this is possibly due to a lack of co-operation on the part of the officials. Of the 5,000 names mentioned 440, or 9.05 per cent., represent the engineering department and only 270 or 5.5 per cent., are officials of the mechanical departments, master mechanics, or higher. It would seem that the relative importance of the mechanical department is such as to warrant a considerably larger number of names. A careful examination indicates that while some master mechanics are mentioned there are a number who are widely known who are not mentioned, and there are a number of motive power officials who have considerably more authority than some of the master mechanics mentioned who really deserve a place and it is hoped that in future editions the selection will be more carefully made. In spite of this deficiency the volume is a valuable one and is an indispensable reference book in every railway library. It is no small task to have gathered this large amount of information together and arranged it properly, and the publishers are to be congratulated upon the results of their labors.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

ELECTRIC GENERATORS.—Bulletin No. 63 from the Crocker-Wheeler Company, Ampere, N. J., presents an extensive list of the users of their direct current engine type generators.

ROOFING RULES.—A handbook on sheet metal in building construction issued by the Merchant & Evans Company, Philadelphia, Pa. The latter part of the booklet contains instructions as to the construction and application of metal roofs.

ARC LIGHTING APPARATUS.—A 40 page bulletin, No. 4428, from the General Electric Company, Schenectady, N. Y., is devoted entirely to the consideration of their various types of arc lamps, light diffusing devices and auxiliary apparatus.

VARIABLE SPEED MOTORS.—Bulletin No. 4430, from the General Electric Company considers the advantages of variable speed motors for use in connection with machine tool drives and illustrates several types of motors and controllers which are recommended for this class of work.

RADIAL DRILLS.—The 1906 catalog of the Fosdick Machine Tool Company, Cincinnati, O., has just been received. It contains an illustrated description of the different lines of radial drills and horizontal boring, drilling and milling machines made by them. Several pages are devoted to motor applications to their radial drills.

HYDRAULIC JACKS.—Sectional catalog No. 86, from the Watson-Stillman Company, New York, describes the various types of hydraulic jacks and auxiliary apparatus made by them. Some of the features illustrated for the first time are the low type journal box jacks; pipe pulling, ring, wedges and faces; bridge transfer jacks used for adjusting ferry bridges to the locking level of car floats and the jack repair vise.

HOLLOW STAY BOLTS.—The Falls Hollow Stay Bolt Company, Cuyahoga Falls, Ohio, are sending out a pamphlet which contains a reprint of a paper on "Coal; its uneconomic use and abuse, generally by steam makers but especially by the railroads, and how to save 50 per cent.," which was presented before the St. Louis Railway Club and also a paper presented before the New York Railroad Club, on "The Quality and Utility of Solid, Flexible and Hollow Staybolts in Iron and Copper." Both of these papers were written by Mr. John Livingstone.

FOUR-CYLINDER BALANCED COMPOUNDS.—This is the title of a pamphlet issued by the American Locomotive Company, containing a paper read before the Railway Club of Pittsburgh, by Mr. F. J. Cole, mechanical engineer. It opens with a discussion of the advantages of this type of locomotive and its development is considered from its earliest stages to the present time. A number of diagrams from early patent specifications are presented. The different forms of crank axles are also illustrated and considered. Several engravings illustrating the more well known English, French and American four-cylinder compounds are presented and the Cole system receives prominent mention.

CALENDARS FOR 1906.—Attractive calendars have been received from the Falls Hollow Staybolt Company, Cuyahoga Falls, O.; H. B. Underwood & Co., Philadelphia, Pa.; The Jeffrey Manufacturing Company, Columbus, O.; Greene, Tweed & Co., 17 Murray street, N. Y., manufacturers of Palmetto packing; Star Brass Manufacturing Company, Boston, Mass.; Cleveland Pneumatic Tool Company, Cleveland. On the Falls Hollow Staybolt calendar is a copy of A. G. Gow's famous painting entitled "Washington's Farewell to His Generals." The Cleveland Pneumatic Tool Company's calendar has a splendid reproduction of a beautiful painting by A. Asti.

LATHES.—Catalog "R" has just been issued by the Lodge & Shipley Machine Tool Company, Cincinnati, O. The details of their improved engine lathes are illustrated and described, and the various sizes of these lathes, from 14 to 48 ins., are illustrated and tables of their leading dimensions are presented. A 24-in. turret chucking lathe, a 24-in extra heavy screw machine and a combination 24-in. turret engine lathe are also illustrated. Several pages are devoted to a description of the patent head lathe and tables of dimensions of the various sizes of this line of lathes are given. The various attachments, which are not regularly furnished with the lathes, are described and several typical motor applications are shown.

DETROIT LOCOMOTIVE LUBRICATORS.—The Detroit Lubricator Company, Detroit, Michigan, has just published a pamphlet descriptive of their new type of locomotive lubricator represented by the "Detroit" No. 21. This lubricator occupies 25 per cent. less space in the cab and has 40 per cent. less parts, 35 per cent. less varieties of parts and 85 per cent. less metal joints than the older type of lubricator. It has a sight feed glass that will not break and the oil is maintained at a uniform temperature and will not chill. The pamphlet considers the advantages of this new type, describes its construction and gives directions for operating it. A number of pages are devoted to helpful hints and other information which will prove of considerable interest and value to those interested in this subject.

GAS ENGINES.—The Westinghouse Companies' Publishing Department has issued reprints of two important pamphlets; one of them, No. 1017, contains an article on "Notes on the Design of Large Gas Engines With Special Reference to Railway Work," by Mr. Arthur West, and also a paper on the "Application of Gas Power to Electric Railway Service," by Mr. J. R. Bibbins. Both of these papers were presented before the American Street and Interurban Railway Association at the Philadelphia Convention, September, 1905. Bulletin No. 1018 contains a reprint of an article, which appeared in *Cassier's Magazine*, on "Gas Power for High Pressure City Fire Service." This article, by Mr. J. R. Bibbins, considers the Philadelphia high pressure pumping station.

NOTES.

GREENE, TWEED & COMPANY.—In order to accommodate their growing business this company has found it necessary to remove to larger quarters at 109 Duane St., New York City.

H. W. JOHNS-MANVILLE COMPANY.—The increasing business of this company has made necessary the establishment of two new departments at the main offices in New York; one of these, known as the railroad department, has been placed in charge of Mr. J. E. Meek. An export department has been organized, under the management of Mr. Wm. Angevine, in order to facilitate the handling of the large foreign business.

CHICAGO PNEUMATIC TOOL COMPANY.—Mr. Wilbur H. Traver, connected with the Rand Drill Company for twelve years, as manager of the Chicago territory and as manager of the railroad department of the Ingersoll-Rand Drill Companies, has taken a position with the above company as manager of their mining and contract departments. He will devote his time principally to the sale of air compressors, rock drills and mining machinery.

RAILWAY APPLIANCES COMPANY.—This company announces that is has purchased and will operate the business of Pedrick & Ayer, at Plainfield, N. J., also that it has taken the sales agency for the Elastic Nut, manufactured by the National Elastic Nut Company of Milwaukee, Wis. Mr. Sheldon E. Bent, who for the past six or seven years has been superintendent of transportation of the Oceanic, of Mexico, and general superintendent of the Vera Cruz and Pacific, will hereafter be connected with the track department.

WM. B. SCAIFE & SONS COMPANY.—This company, of Pittsburgh, announces that they have secured the following contracts: A structural steel boiler house for the Washington Coal & Coke Company, Star Junction, Pa. The construction and erection of steel frame buildings required by the Firth-Sterling Steel Company for their new ordnance plant at Washington, D. C. A large amount of structural steel work to be used in connection with the new plant of the New York State Steel Company at Buffalo, N. Y.

CHICAGO PNEUMATIC TOOL COMPANY.—The annual report to the stockholders of this company indicates a very satisfactory condition of affairs. In addition to the 4 per cent. dividend for the year, $315,134.39 has been carried to the surplus account as additional working capital, required on account of the enlarged scope of operations and the increased volume of business. During the past year the Consolidated Pneumatic Tool Company, Ltd., of London, has been developing the organization of the Fraserburgh plant in Scotland, until it is at the present time running to its full capacity. The International Compressed Air & Electric Company, Berlin, has been organized. The Philadelphia Pneumatic Tool Company of Philadelphia has been acquired, as has also the business and plant of the Canadian Pneumatic Tool Company, Ltd., of Montreal, Canada.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

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SOUTH ALTOONA FOUNDRIES.

Pennsylvania Railroad.

The wheel and grey iron foundries of the Pennsylvania Railroad were formerly located at Altoona in connection with the locomotive repair department. They were old and not equipped with modern facilities, were entirely too small and the space occupied by them was badly needed for the extension of the locomotive repair department. A comparatively small proportion of the output of the foundries is used by this department at Altoona, and the amount of material received and shipped to other parts of the system, by the foundries, is so great as to make it advisable to have them entirely separated from other departments and located so that good shipping facilities are afforded to all parts of the system. To increase the output and to operate with greater economy it was necessary to build an entirely new plant. As foundry work is purely a manufacturing proposition, and as the combined foundries were of such magnitude as to require a separate department, it was decided to remove them to South Altoona, about two miles from the Altoona shops. It is proposed, as far as possible, to concentrate the foundry work for the entire system at this point.

This new plant, at present, consists of a wheel foundry, grey iron foundry, machine shop and material building, pattern shop, power house and a handsome two-story brick, 40x60 ft., office building. It is located on a plot of ground 5,500 ft. long and of an average width of 900 ft., extending alongside the single-track Hollidaysburg branch, which connects Altoona to the low grade freight line, extending between Galitzin and Huntingdon, at Hollidaysburg. This plot is large enough to provide, if necessary, for a generous extension of the present foundries and also for the future addition of brass and cast-steel foundries. The details of the design and operation of the plant were carefully worked out by the railroad company, and it is undoubtedly the most complete plant of its kind in this country.

WHEEL FOUNDRY.

The wheel foundry has a capacity of 900 wheels per day, which is greater than that of any other wheel foundry under one roof in this country. It is a steel frame brick building. The interior is a single room 600 ft. long and 186 ft. wide, with no divisions between the moulding floors, annealing pits and cleaning rooms, but with a space 60x410 ft. enclosed for the cupola, sand storage, core and wash rooms. These rooms have brick partitions. The long side of the building is divided into thirteen 46-ft. bays; each bay has nine roof trusses, spaced 23 ft. apart. The trusses are independent of the walls and partitions and are supported by steel columns arranged in fourteen longitudinal and nine transverse rows. The side walls are composed very largely of glass, and the monitors, which extend across each section of the building, have skylights their entire length, so that the day-lighting is excellent. The monitors are wide and high and equipped with swinging sash, thus affording splendid ventilation.

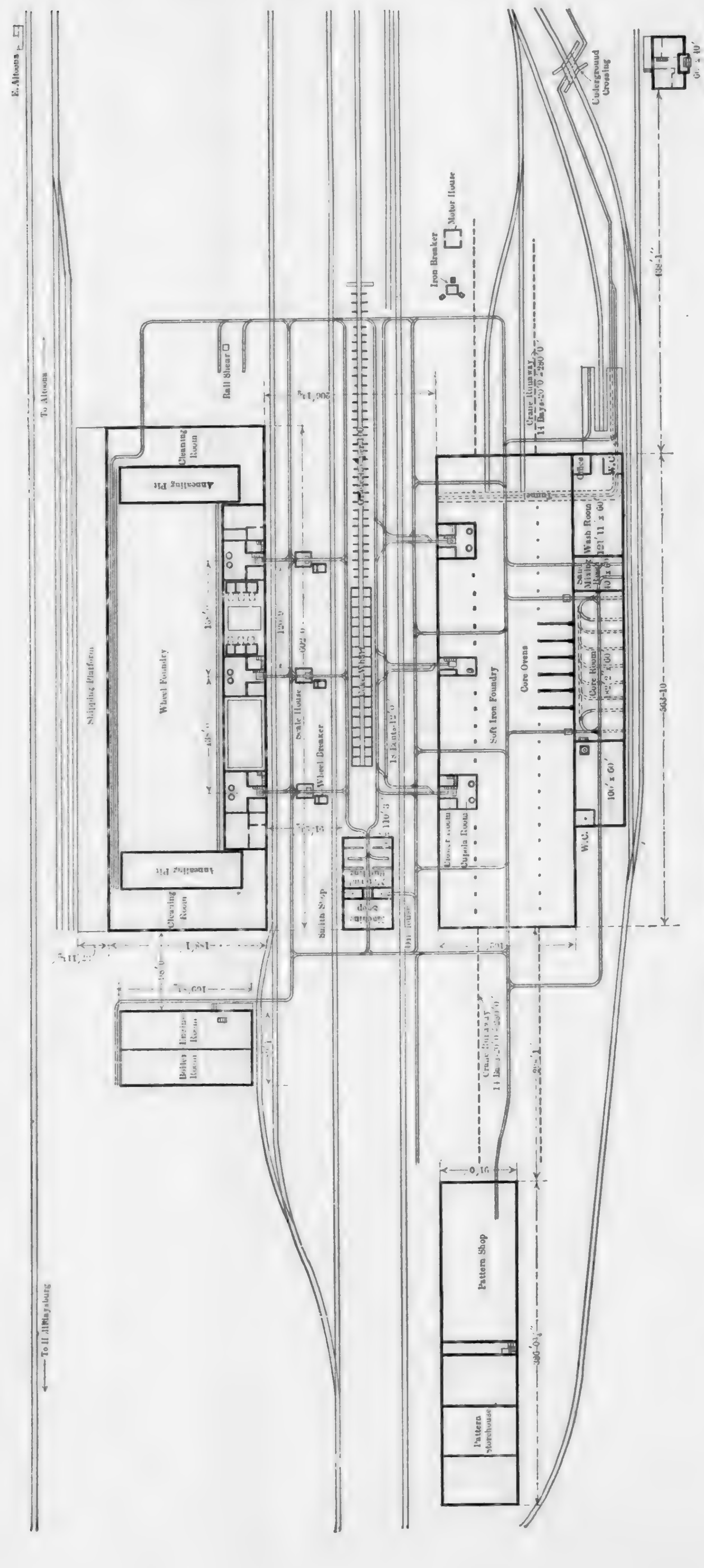
Referring to the floor plan of the building it will be seen that the arrangement is symmetrical about the centre transverse axis. With the exception of the cleaning rooms and annealing pits at each end of the foundry, it is, however, made up of three complete divisions, each consisting of a pair of 86-in. Paxson-Colliau type cupolas and twelve 25-wheel moulding floors, each served by an independent trolley or hoist, but all dependent upon a system of longitudinal cable cars for the delivery of the molten iron and for the removal of the wheels to the annealing pits at each end of the moulding floor. Each of these three divisions is practically independent of the others.

The compact and efficient working of the wheel foundry can probably be best understood by following the course of the raw material from the storage yard until it reaches the shipping platform in the shape of a finished wheel. Referring to the general plan of the plant it will be seen that the storage space between the wheel and grey iron foundries, and adjacent to the former, is divided into three sections corresponding to the divisions of the wheel foundry. The supplies are delivered on the standard gauge tracks and are distributed throughout the plant by small cars on the narrow gauge tracks. Coal and coke are unloaded by gravity from hopper-bottom cars into the bins underneath the long trestle.

Small flat cars are loaded by hand with the required class of pig-iron, are then pushed on the scale in the weighing room, where the proper amount of broken car wheels is added to make up a load of 2 tons. The car is then pushed on to the platform of the hydraulic plunger elevator, 5 tons capacity, in the cupola room, and is raised to the charging floor, pushed alongside one of the two cupolas and its contents charged by hand. Each of the cupolas has a capacity of 12 tons per hour.

Near each scale house is a wheel breaker where old wheels are broken by a 1,700-lb. hammer falling 19 ft. on a concave anvil block imbedded in the ground. The weight is raised by hydraulic power. The breaker is enclosed in a steel frame structure 8 ft. 6 ins. by 15 ft. The outside covering is corrugated iron laid on white pine. On the inside there is a 2-in. oak lining 13 ft. high and this is covered with ¼-in. steel plate for a height of 8 ft.

Two of the cupolas are provided with Sturtevant No. 10 blowers driven by 60 h.p. motors, and the other four are provided with 55-in. Sirrocco blowers furnished by Davidson & Company, Belfast, Ireland, and driven by 60 h.p. Westinghouse motors. Each blower is enclosed in a small room.



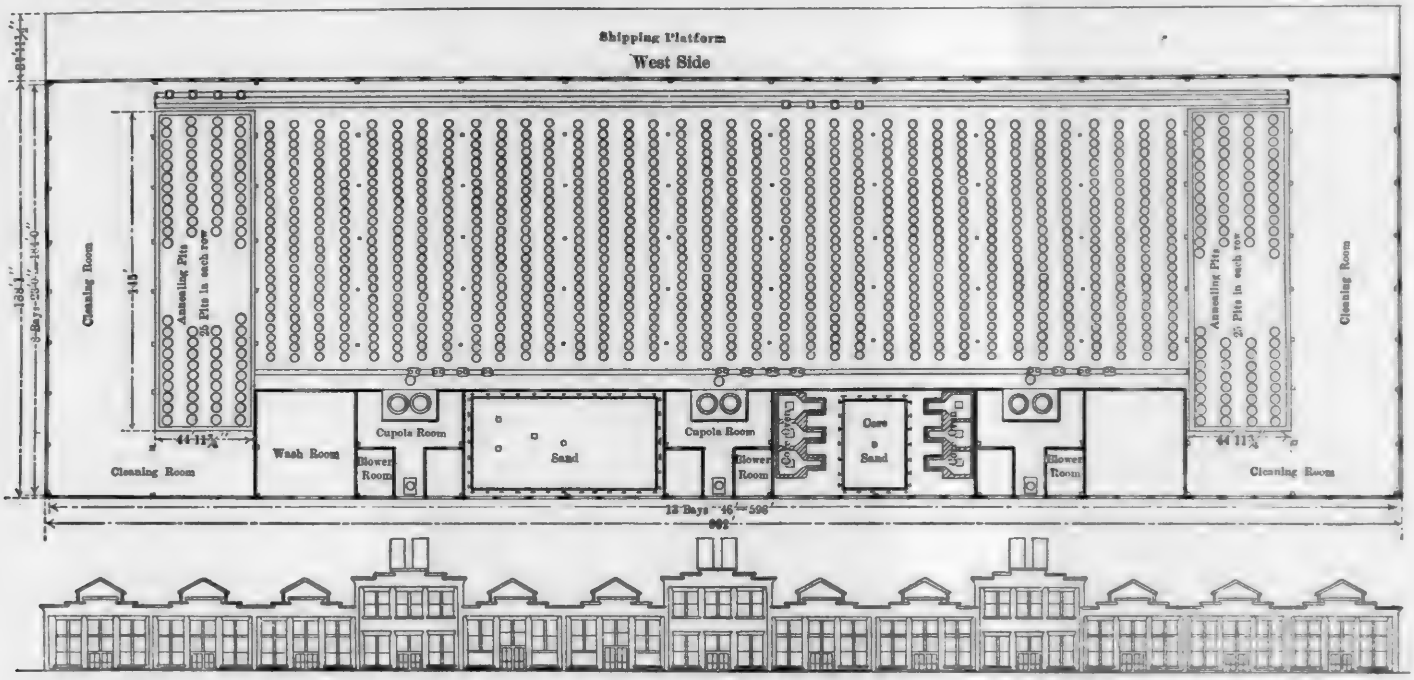
GENERAL PLAN OF SOUTH ALTOONA FOUNDRIES—PENNSYLVANIA RAILROAD.

The core room is located between two of the cupola rooms and is equipped with two sets of three ovens; a coke furnace underneath each oven is fired from a pit under the core room floor, and has two flues which deliver the gases to the rear corners of the oven, where they rise, pass up through the shelves at the back to the top and then return to the floor and to the outlet at the lower front corner. In the centre of each oven is a vertical shaft with collars which support seven shelves of 3/16-in. perforated tank steel 10 ft. 6 ins. in diameter and spaced 13⅛ ins. apart. The shelves are mounted on ball bearings and revolve independently. Between the two sets of ovens is a 40x28x10-ft. (550-ton) sand bin with wooden walls 2½ ins. thick, supported by an outside steel frame work of 12-in. I beams.

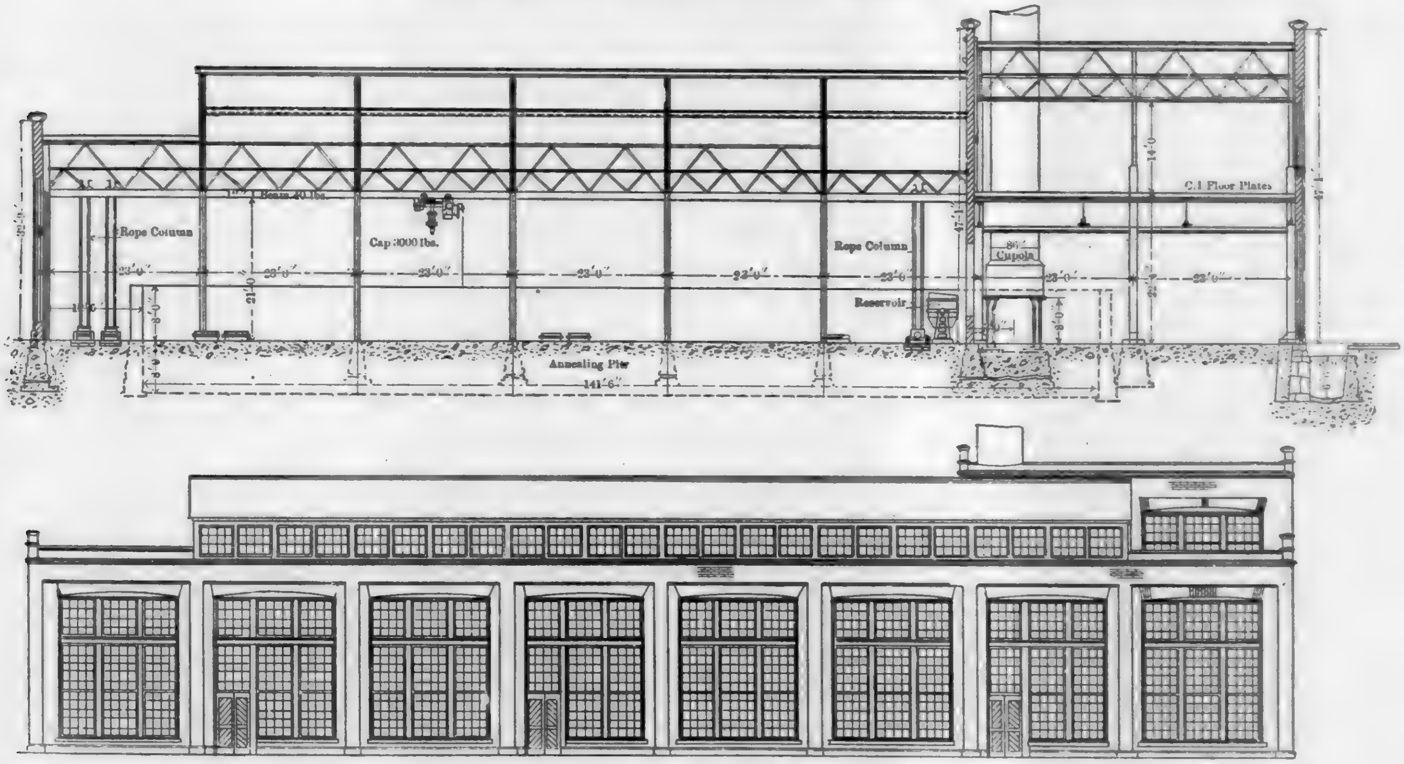
The sand for the moulders' use is stored in a 40-ft. 9-in. x 82-ft. 3-in x 12-ft. (1,840-ton) bin. The sand is sifted by an electrically driven machine manufactured by the Fairbanks Company, Springfield, Ohio, and is delivered to the moulding floor in wheelbarrows.

Each bay in the foundry proper covers one unit of four moulders' floors, each of which is 11 ft. wide, extending across the foundry, and has on the centre line a pair of rails 24 ins. apart, upon which 25 flasks are set. There are thirty-six of these rows, which give a maximum capacity of 900 wheels per day, assuming that one is obtained from each flask. Over each row of moulds is a specially designed Sprague electric trolley hoist. These hoists run on 12-in. I beam tracks, and both the hoisting and traversing operations are controlled by one handle, which can be reached from the floor, and is so arranged that if desired both operations may be carried on at the same time. They have several hoisting speeds, ranging from 16 to 75 ft. per minute, and a range of traversing speeds up to 400 ft. per minute. The nominal capacity is a lift of 1,000 lbs. at 60 ft. per minute. The tracks for these hoists extend beyond the line of flasks and over the narrow gauge tracks at each end of the moulding floor.

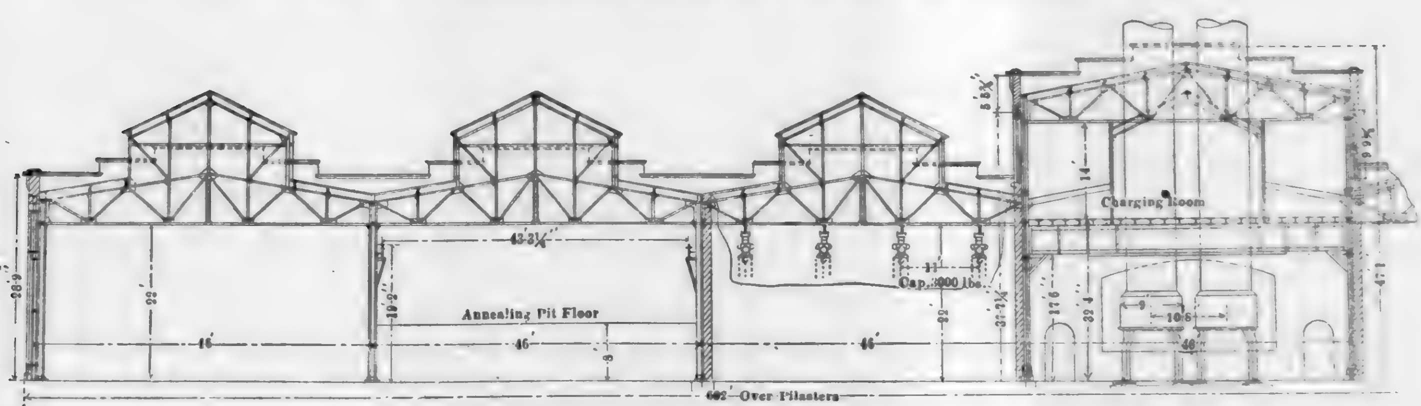
Each pair of cupolas discharges into a reservoir of 14,000 lbs. capacity, consisting of a brick-lined steel shell mounted on trunnions. These reservoirs are tilted by a chain which passes over a sheave on the end of the trunnion shaft and is operated by an hydraulic cylinder located underneath the bed-plate and controlled by a valve conveniently placed. In front of each of these reservoirs is a narrow gauge track upon which four small ladle cars coupled together are operated by a cable driven by a reversi-



PLAN AND SIDE ELEVATION OF WHEEL FOUNDRY.



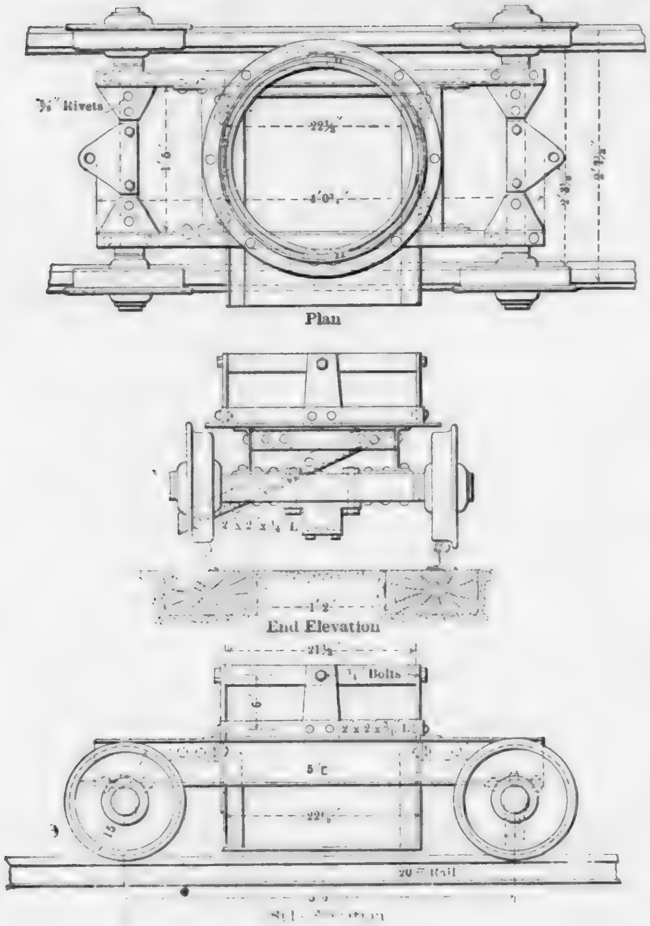
END VIEW AND TRANSVERSE SECTION THROUGH THE MOULDING FLOOR AND CUPOLA ROOM.



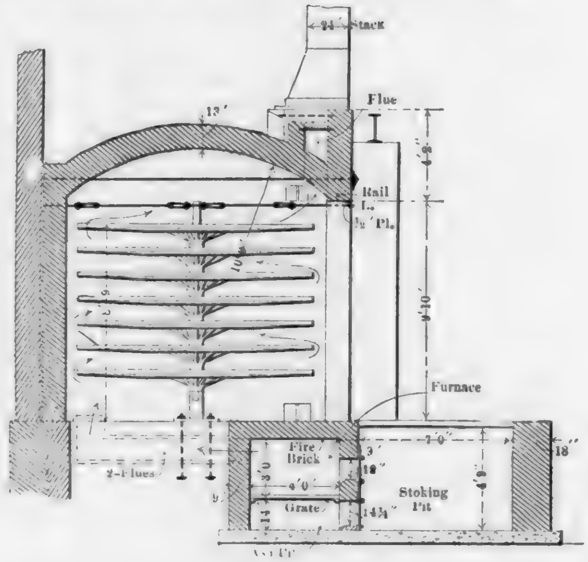
PART LONGITUDINAL SECTION AT ONE END OF FOUNDRY.

WHEEL FOUNDRY, SOUTH ALTOONA—PENNSYLVANIA RAILROAD.

MOULDING FLOOR, SOUTH ALTOONA WHEEL FOUNDRY.



HOT WHEEL CAR.



CORE OVEN.

ble electric motor. Each car consists of a shallow steel shell or box mounted on four wheels and designed to carry a 1,000-lb. ladle on each end. The reservoir is so arranged that the flow from the cupola does not have to be stopped while it is being tilted to supply the pouring ladles. As soon as the pouring ladles, each of 1,000-lbs. capacity, on the four cars, have been filled, they are run opposite the set of four rows of moulds which are to be poured off. The cars are spaced the same distance apart as the rows of moulds, and the ladles therefore stop directly under the four hoists. As soon as the ladles have been removed the cars are moved to another set of moulds, where they pick up the empty ladles which they had previously delivered and return to the reservoir. As each train of cars takes care of three units of four moulding floors, they are in continual operation during the process of pouring off.

On the opposite side of the foundry from the cupolas are two duplicate haulage systems parallel to each other and close together, upon which the cars which deliver the wheels from the moulding floors to the annealing pits are operated. Two trains of four cars each, spaced 11 ft., centre to centre, operate on each track. As soon as the flasks have been uncovered the wheels are removed and placed on the cars by the trolley hoists. The four cars are loaded at the same time. The wheel is laid on an angle iron ring supported at four points from the framing of the car and having an inclined platform or chute under it, so that the sand can fall freely through the ring and frame and be delivered by gravity to the floor

outside of the track and in a convenient position to be removed without interfering with the operation of the trains. The trains are operated by a controller located in a cage near the annealing pits and high enough above the floor to furnish a good view for the full length of the track.

VIEW OF THE WHEEL FOUNDRY SHOWING STORAGE PLATFORM.

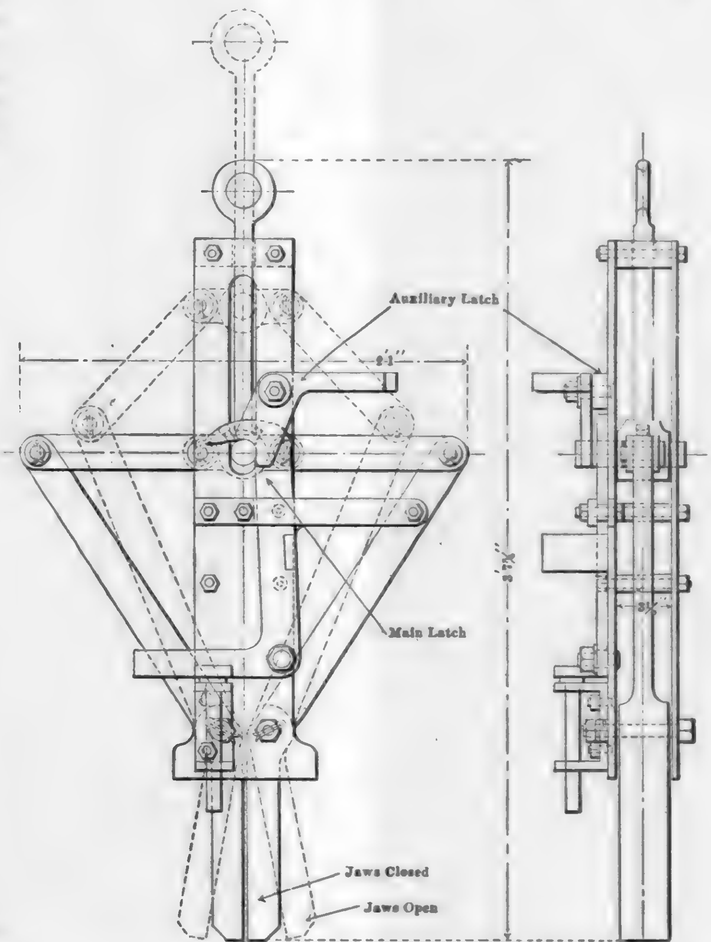
The two annealing pits, 41x140 ft., have an inside depth of about 17 ft. The masonry retaining walls, which enclose each side of the pits, rise about 8 ft. above the foundry floor. The bottom of the pit is covered with 6 ins. of concrete, sloping toward one corner, for drainage. Four rows of 25-sheet steel brick-lined cylinders, 40 ins. inside diameter and 16 ft. high, each having a capacity of 25 wheels, are supported on concrete platforms or benches 18 ins. above the bottom of the pit, and spaced 11 ft., centre to centre. The tanks are made of ⅜-in. steel, are lined with 6 ins. of fire brick and are spaced about 18 ins. apart. The space between the platforms is filled with coarse broken stone, between the tanks is a layer

WHEEL TONGS.

of fine stone, and above this green and burnt sand to the top of the walls.

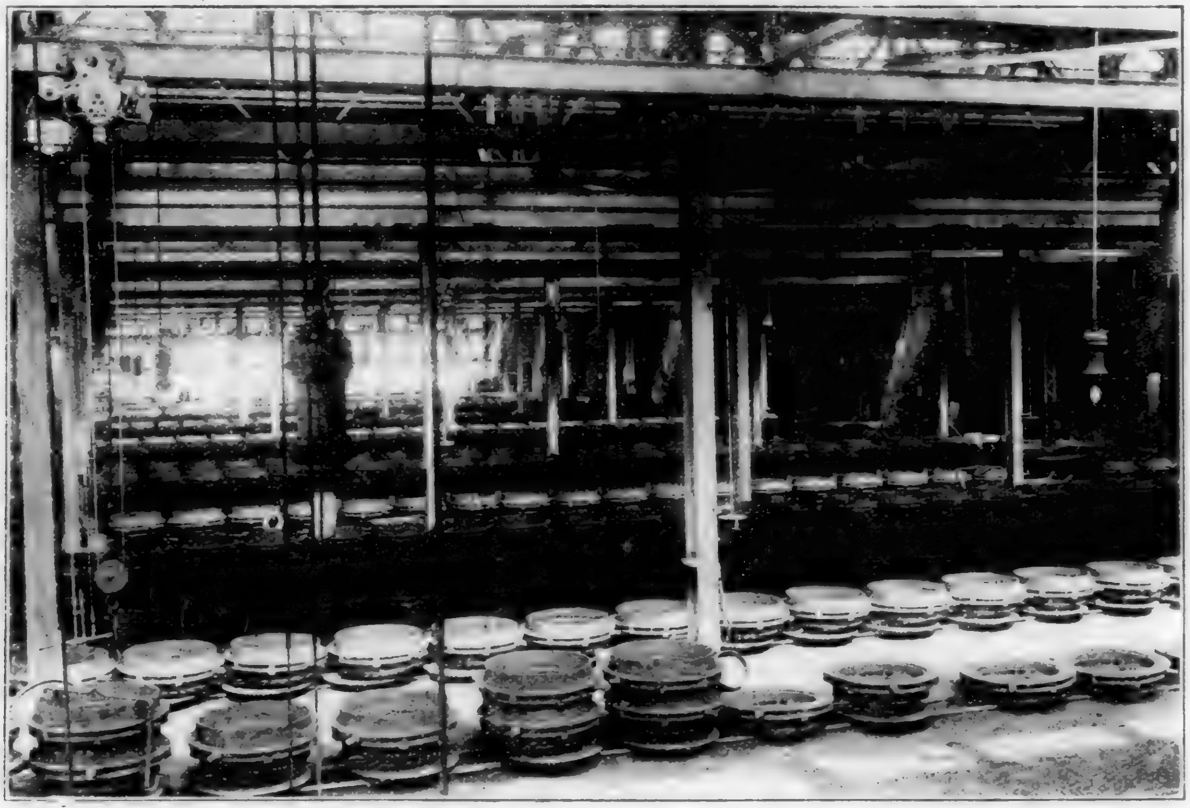
Extending over each annealing pit is a traveling crane having a span of 44 ft. and a capacity of 4,000 lbs. This crane has four independent hoists, spaced 11 ft. apart, each driven by a 7½ h.p. motor, controlled separately from the cab. The crane is operated by a 10 h.p. motor and traverses at a speed of 500 ft. per minute. The hoists operate at speeds up to 100 ft. per minute. There is a spare hoist on the bridge and an extra motor for traversing which can quickly be connected up in case the regular motors should get out of order.

The wheels from the moulding floor, which are delivered in sets of four, are removed by the four hoists and are placed in the annealing pits, the cars returning for another load. An ingenious and special design of tongs developed at Altoona is used for lifting the wheels from the cars and depositing them in the annealing pits or for removing them from the pits. These tongs consist of two bent links hinged near the bottom of the frame work, the lower end of the links or jaws extending below the frame. The upper ends of the links are joined by toggle links, and these toggle links are connected by a pin, which is guided by a slot in the frame work and one end of which projects beyond the side of the frame. A latch having a horizontal arm at the bottom and with a hook on the side of the vertical arm is hinged near the bottom of the frame work in such a position that the hook may extend over the pin at the toggle connection and thus hold the jaws closed. As the jaws are lowered into the cored hole in the wheel a vertical pin, which is carried in a guide and extends below the frame work, comes in contact with the hub of the wheel, forces the horizontal arm of the latch upward, thus

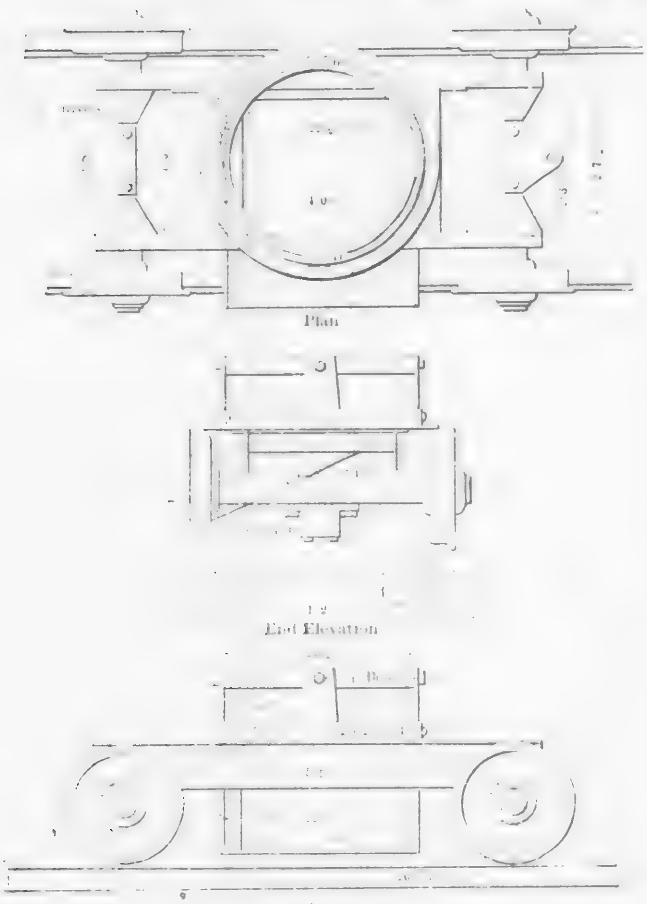


WHEEL TONGS.

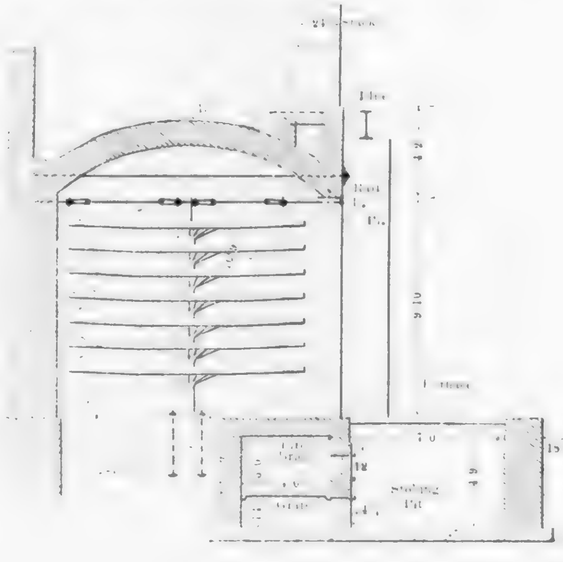
throwing the hook which locks the toggle connection to the right. As the tongs are hoisted the lower jaws are forced outward and firmly grip the wheel. Near the top of the frame work is hinged an auxiliary latch with an extended arm, by which it may be thrown in or out of operation. Before lowering the wheel into the annealing pit this auxiliary latch is thrown over so that when the wheel strikes the bottom the toggle closes and the auxiliary latch engages the pin and prevents the tongs from again griping the wheel.



MOULDING FLOOR, SOUTH ALTOONA WHEEL FOUNDRY.



HOT WHEEL CAR.



CORE OVEN.

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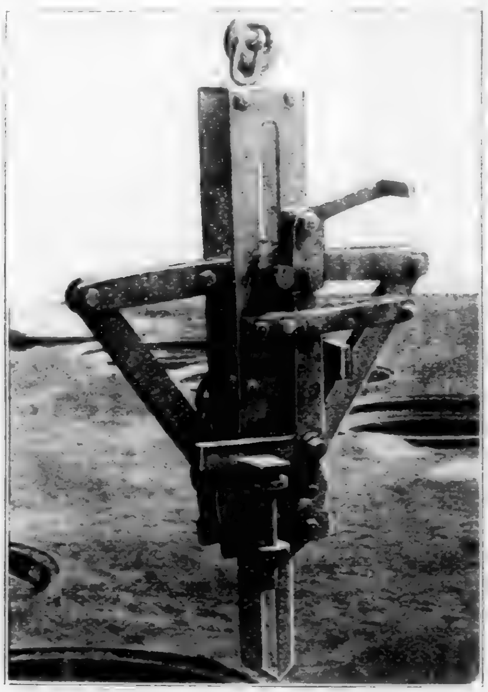

WHEEL TONGS.

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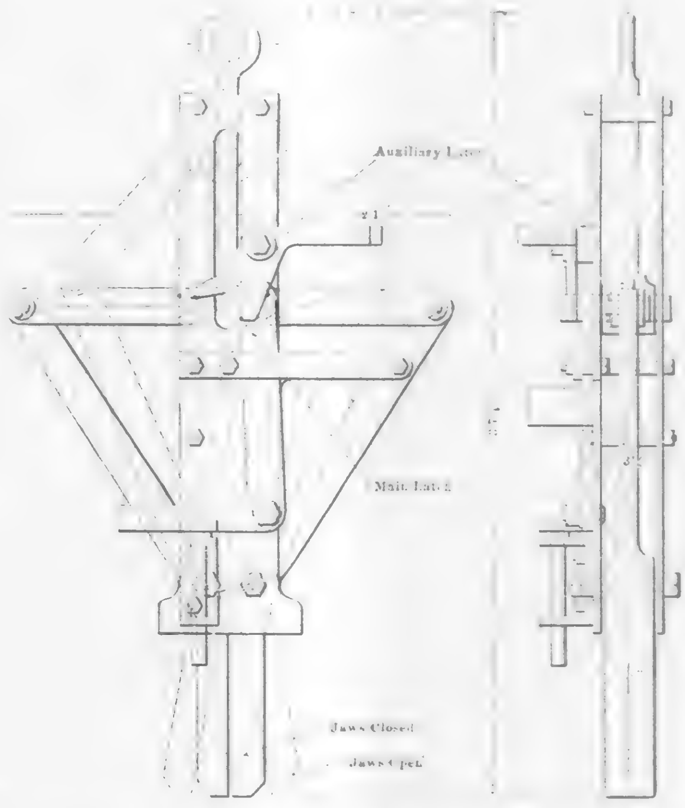

WHEEL TONGS.

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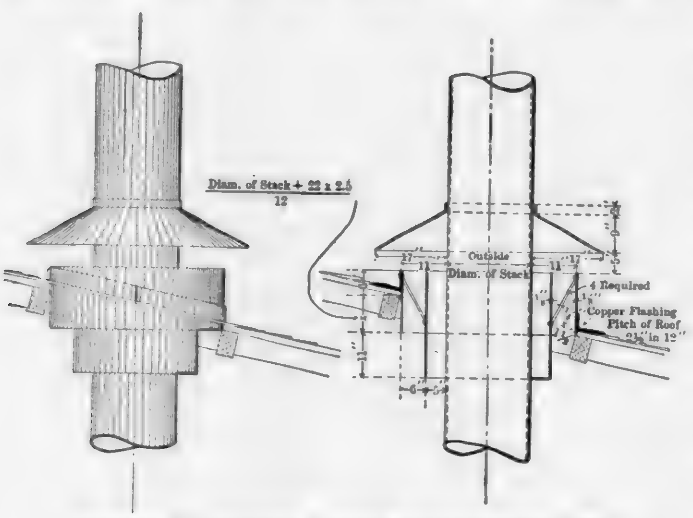
After remaining in the annealing pits five days the wheels are taken out and delivered to the cleaning floor at the opposite end of the pits from the track on which they are delivered, and after they have been cleaned, inspected and measured are rolled to the storage platform, which is on a level with the cleaning floor, is 38 ft. wide, extends along the full length of the foundry, and is 4 ft. above the top of the shipping track, so that the wheels can be rolled directly into the cars. This storage platform will hold about 5,000 wheels.

The method of carrying the stacks through the roofs of the foundry buildings in order to provide a generous air space around them and protect the roof from heat, and at the same time to keep out rain and snow, is a very ingenious one, and is illustrated in detail on the accompanying engravings. The dimension X is derived from the following formula: Diameter of the stack plus 22 times the pitch of the roof in 12 ins. divided by 12. The other dimensions shown are the same for different roof pitches and for all diameters of stacks except the very large ones. For very large diameter stacks, such as for the wheel foundry cupola, which are about 7 ft. 3 ins. in diameter where they pass through the roof, a thicker plate



METHOD OF CARRYING STACKS THROUGH THE ROOF.

is used for the circular bands, and they are reinforced by light steel angles riveted at both the top and bottom. Other details and dimensions are also varied slightly to furnish the requisite strength and stiffness.

The building is heated by the Sturtevant system. The hot air pipes are carried above the roof trusses and branch pipes deliver the air near the floor level at the columns.

Enclosed arc lights are hung close to the roof trusses. For lighting the storage platform and the storage yards, enclosed arc lights are hung from the exterior walls of the buildings. At each end of the foundry there is a 44x48 ft. wash room, which includes a dressing room with expanded metal lockers, a toilet room with porcelain fixtures, 50 porcelain washbasins, a row of 6 shower baths, which are supplied with both hot and cold water.

MACHINE SHOP AND MATERIAL BUILDING.

The machine shop and material building is of brick and about 60x100 ft. About one-third of it is used as a machine shop, the work consisting largely of the making of car wheel chills. The rest of the building is used for the storage of fire clay, fire brick and manganese, and small portions are partitioned off for a smith shop and an oil house.

(To be continued.)

TIRE TURNING.—I make it a rule and hope that I get those results in our shop, that there must be no full set of tires turned on any engine without one of those tires shows a witness mark. That is supposed to be the smallest tire of the set. By witness mark I mean that there must be a black spot, perhaps as large as your finger that the tool has not touched.—*Mr. A. E. Manchester, Western Railway Club.*

STANDARDIZING LOCOMOTIVE EQUIPMENT.

CANADIAN PACIFIC RAILWAY.

The locomotive equipment of the Canadian Pacific Railway, like that of all roads of similar age and size, consists of a miscellaneous and very varied collection of old, middle-aged and new power, and contains examples of practically every step in locomotive development from the time the road was first incorporated. This road has, however, for years past, kept in mind the advantages obtained from a proper standardization of as many parts of a locomotive as possible, even though the type of engine as a whole may vary, and in establishing a new and heavier series of engines which are designed to meet the demands of the present time, the motive power department of this road has carried out this principle by making as many locomotive parts as possible, interchangeable between such classes of locomotives as conditions of design, construction and operation would permit.

In undertaking the work it was clearly recognized that there was a limit beyond which standards would become as great an evil as their entire absence, and so a careful study of all affecting conditions was made in every case to determine just how far to carry the work. This resulted, in some cases, of a part being standard for only one or two classes and somewhat modified for others, and in other cases of it being standard for all engines. Taken as a whole, the standardization has been carried much farther than has been done heretofore, and some parts have been brought to a standard basis which have formerly been considered to be outside the practical range. The cylinders and valve motion are examples of this.

Another factor which also had a direct influence on the final result was the fact that it was advisable, as far as possible, without affecting their value for future work, to retain many old parts which had been satisfactory and could with a small change be made to serve on several different classes.

With these governing features in mind, a very complete set of standard locomotive parts have been adopted, which, while it is expected that they will be strictly maintained on new power for the next five years, are also interchangeable on a surprisingly large number of the older engines.

The locomotive equipment of this road consists of 1,075 locomotives divided into 47 different classes, each class having from 1 to 94 engines, and in many cases being divided into a number of sub-classes. It includes simple engines having cylinders varying from 15 by 24 ins. to 21 by 28 ins., and boiler pressures from 130 to 210 lbs. per sq. in. There are included 321 two-cylinder compound locomotives, which is probably a greater number than will be found on any railroad in this country. These have cylinders varying from 19 and 29 by 24 ins. to 22 and 35 by 30 ins.

In the use of superheaters this road occupies the position of being the pioneer, and also of having by far the largest number in operation of any American railroad. There are altogether 187 locomotives built and on order (see table herewith) equipped with superheaters, which include examples of practically every known design except the Pielock. There is one engine fitted with the Schmidt smokebox superheater; 32 with the Schmidt boiler tube type; 62 with the Cole type, 22 of which have the internal superheating tube and 40 the return bend. All of these designs were illustrated and thoroughly described in Mr. Vaughan's paper on superheating read before the last convention of the Master Mechanics' Association. There are also 92 locomotives fitted with the Vaughan-Horsey superheater (AMERICAN ENGINEER, February, 1906, page 41). In every case of both compound and superheater engines there are simple fire tube engines in the same class with which comparisons of operation can be made.

A system of per cent. rating for locomotives is in use on this road which is based on tractive power, a 100 per cent engine being one with 20,000 lbs. tractive effort, and the others being rated from that basis. This rating is used by both the operating department for dispatching and the motive power

department in its record of locomotive repairs and shop output.

On this basis the motive power of the Canadian Pacific varies between locomotives of 50 and 180 per cent., and has a single example of a 225 per cent. engine; this, however, being a geared logging engine, is not considered part of the ordinary equipment. It includes all of the usual types of wheel arrangements, but with the 10-wheel and consolidation types largely predominating, the former including 433 engines

LOCOMOTIVES EQUIPPED WITH SUPERHEATERS.

No.	Type of engine.	Class.	Cylinders, Simple or Com.	Size.	Remarks.
1	4-6-0	D.2	Simple	18" x 24"	Schmidt smokebox, In ser.
1	4-6-0	D.6	2-cyl. cross compound	20" & 33 x 26	Schmidt firetube, In ser.
1	4-6-0	D.9	2-cyl. cross compound	22" & 35 x 30	Schmidt firetube, In ser.
1	4-6-0	E.2	Simple	19" x 24"	Cole firetube, In ser.
21	2-8-0	M.4	Simple	21" x 28"	Cole firetube, In ser.
20	2-8-0	M.4	Simple	21" x 28"	Schmidt firetube, In ser.
10	4-6-0	D.10	Simple	21" x 28"	Schmidt firetube, In ser.
30	4-6-0	D.10	Simple	21" x 28"	Cole firetube, In ser.
10	4-6-0	D.10	Simple	21" x 28"	Vaughan-Horsey, F. T., In ser.
5	4-6-0	D.11	Simple	21" x 28"	Vaughan-Horsey, F. T., In ser.
3	4-6-2	G.1	Simple	21" x 28"	Vaughan-Horsey, F. T., In ser.
3	4-6-2	G.2	Simple	21" x 28"	Vaughan-Horsey, under construction.
1	4-6-0	E.5	Simple	20" x 26"	Vaughan-Horsey, In ser.
50	4-6-0	D.10	Simple	21" x 28"	Vaughan-Horsey, under construction.
10	4-6-0	D.10	Simple	21" x 28"	Cole firetube, under construction.
*20	2-8-0	M.4	Simple	22½" x 28"	Vaughan-Horsey F. T., under construction.

*With these engines the boiler pressure will be 175 lbs., and cylinders have been enlarged in diameter to give the same power as similar engines having 200 lbs. boiler pressure and 21 x 28 cylinder.

of from 90 to 160 per cent. and the latter 230 engines from 100 to 180 per cent.

In undertaking under these conditions to make standards which will be of value for future power, it is easily understood that the smaller and older engines must be eliminated to a large extent, and in this case standard parts cover broadly but three types, the consolidation, the 10-wheel and the Pacific, as typified by classes M4, D10 and G1. Class D11 is the same as D10 with a different boiler, which is arranged for burning culm. Class D9 is an older class of 37 10-wheel freight engines, which was in operation before the work of standardizing

Class.	Type.	Cylinders	Dia. Drivers.	Per. Cent. Power.
M4	2-8-0	21 x 28	57	180
D10	4-6-0	21 x 28	63	155
D11	4-6-0	21 x 28	63	155
G1	4-6-2	21 x 28	75	140
G2	4-6-2	21 x 28	69	152

was undertaken, and with class M3, 42 compound consolidation, and class E5, 70 10-wheel passenger engines, has been followed in many respects in order to utilize as far as possible existing designs. Classes G1 and G2 are practically identical, except for size of drivers. On the five classes included the completeness of the work can be understood when it is stated that fully 60 per cent. of the parts are interchangeable.

The following will show clearly how broad a field has been covered by the standard parts and also the types of locomotives in each class. In the table, "X" is used to denote that the part is used on all classes marked. "Standard" denotes that the part is used with slight changes on all classes, and "Standard on all classes" denotes that the identical part is used on all classes:

	M4	D10	D11	G1	G2	No. of old engines using similar parts.
Axles, driving	X	X	X	X	X	162
Axles, engine truck	X	X	X	X	X	162
Axles, tender	X	X	X	X	X	211
Bell and ringer	STANDARD FOR ALL CLASSES.					
Fire box types (wide and radial stayed)	X	X	X	X	X	...
Fire box water space, F 5½, S 4½, B 3½	X	X		X	X	...
Boiler seams	STANDARD FOR ALL CLASSES.					
Crown stay, diameter	STANDARD FOR ALL CLASSES.					
Boxes, driving	X	X	X	X	X	143
Boxes, engine truck	X	X	X	X	X	105
Boxes, tender	X	X	X	X	X	211
Air reservoir, size	STANDARD					
Air pump bracket	STANDARD FOR ALL CLASSES.					
Brake shoes	STANDARD FOR ALL CLASSES.					
Bumper beams, knees and push boxes	X	X	X	X	X	114
Cab	X	X	X			All similar.
Cab ventilator	STANDARD FOR ALL CLASSES.					
Cab bracket	STANDARD FOR ALL CLASSES.					
Cab fittings throughout	STANDARD FOR ALL CLASSES.					
Cylinder cocks	STANDARD FOR ALL CLASSES.					
Crank pins			X	X	X	162
Cross Head and wrist pins	X	X	X	X	X	162
Cylinders	X	X	X			...
Cylinders G1 (same except saddle)				X	X	...
Cylinder head and casing	X	X	X	X	X	...
Cylinder vacuum & relief valves	X	X	X	X	X	...
Dome cap, ring and casing	X	X	X	X	X	...
Draw gear engine	X	X	X			...
Engine truck		X	X	X	X	...
Exhaust pipe and nozzle		X	X	X	X	...
Eccentric and strap	X	X	X	X	X	38
Fire door	X	X		X	X	...
Frame pedestal	X	X	X	X	X	...
Shoes and wedges	X	X	X	X	X	...
Frame foot plate	X	X	X			...
Frame foot plate				X	X	...
Expansion pad and knee	X	X	X			...
Guides		X	X			...
Guides				X	X	...
Grates frames	X	X		X	X	...
Grate bars	STANDARD.					
Hand rail and steps	X	X	X	X	X	...
Head light	STANDARD FOR ALL CLASSES.					
Cab lamps	STANDARD FOR ALL CLASSES.					
Number plate	STANDARD FOR ALL CLASSES.					
Gauges and small fixtures	STANDARD FOR ALL CLASSES.					
Injector	X	X	X	X	X	113
Injector pipes and valves	STANDARD.					
Boiler lagging	STANDARD.					
Cylinder and steam chest lagging	X	X	X	X	X	...
Link motion complete	X	X	X	X	X	Rad. of link changes.
Oil cups and lubricators	STANDARD FOR ALL CLASSES.					
Pilot	STANDARD.					
Pipe fittings	STANDARD.					
Pistons	X	X	X	X	X	4
Piston packing	STANDARD.					
Piston rods, material, steel	STANDARD.					
Wash out plugs	STANDARD FOR ALL CLASSES.					
Reverse lever	DUPLICATE IN PART.					
Reverse shaft	X	X	X	X	X	...
Reach rod (Length varies)	X	X	X	X	X	...
Rockers and boxes	X	X	X	X	X	...
Main rod, details	X	X	X	X	X	...
Slide rod, details	X	X	X	X	X	...
Knuckle pin	X	X	X	X	X	...
Sand box	STANDARD.					
Smoke box arrangement	STANDARD.					
Smoke stack daimeter		X	X	X	X	...
Springs	STANDARD.					
Spring rigging	STANDARD.					
Steam chest covers and casing	X	X	X	X	X	...
Safety valve	STANDARD.					
Steam pipes and T heads	M4e	D10c	X	X	X	...
V & H superheater T head	X	X	X	X	X	...
V & H superheater steam pipes, same except for set in G1&2	X	X	X	X	X	...
Tank valves, hose, strainer, etc.	STANDARD.					
Tender brake and rigging	STANDARD.					
Tender frame	STANDARD.					
Tender attachments	STANDARD.					
Tender tank	X	X	X			...
Tender tank				X	X	...
Tender tank filling hole and drain pipe	STANDARD FOR ALL CLASSES.					
Tender truck	STANDARD.					
Throttle		X	X	X	X	...
Dry pipe	X	X	X	X	X	115
Engine tools	STANDARD.					
Valve setting	X	X	X	X	X	...
Valve rod		X	X	X	X	...
Wheels and tires		X	X			...
Engine truck wheels and tires	X	X	X		X	82
Tender wheels and tires		X	X	X	X	...
Whistle and rigging	STANDARD.					

BOILER CIRCULATION.—It is probable that in the wider fireboxes, the main mass of the fire being so much nearer the tube-plate, has a bad effect on the tubes, as the intensity of the temperature at the tube-plate must ncessarily be much increased. The extra width of the box has enabled the tubes to be put much too near the sides of the barrel. When this is done, the water to feed up the spaces between the tubes near the back tube plate has to be drawn almost entirely from the front of the barrel, and it is possible that in some cases the space left for this purpose is inadequate. It will probably be found that neglect of this consideration is the cause of three-fourths of the tube trouble. There is no doubt that the upward draught of water through the spaces between the tubes for, say, 2 ft. from the back tube-plate, is very strong indeed, and in all probability this is enough to prevent the necessary feed of water down the spaces of the firebox unless ample area is given, so causing stay as well as tube trouble.—*Mr. G. J. Churchward, before the Institution of Mechanical Engineers.*

DEPARTMENT OF TRANSPORTATION—McGILL UNIVERSITY.

Experience has shown that the great majority of university and college graduates know nothing of practical business ways and means when they leave college. This lack is particularly felt by the railroad officials, who have become suspicious of a system of education which omits from its curriculum the factors necessary to enable the student to apply his technical knowledge in the solving of practical questions.

With a view to correcting this unfortunate condition, McGill University, at Montreal, Canada, with the aid of the Canadian railways, has organized a department of transportation for those who intend to take up railway service as a profession, offering courses in the theory and practice of railways and in mechanical and civil engineering as specially adapted to railways.

The Canadian railways are backing the scheme and paying for it because they hope to get better men and more of them who are of the kind they can make leaders of. The department has been placed in charge of Mr. Clarence Morgan. The courses are designed for students who wish to enter the operating department or executive offices, the motive power department, or the engineering department, and as far as possible they will include active employment by the railways during the summer vacations.

The work of the first two years follows those of the other departments in the faculty of applied science, covering very thoroughly mathematics, physics, mechanical drawing, kinematics of machines, materials of construction and shop work. During the third and fourth year the students will specialize along the lines of the several courses. After graduation the students in the engineering courses will be expected to serve an apprenticeship of 2½ years on the railroad. It is hoped in this way to develop men who, by a thorough grounding in preliminary work, will be able to assume positions of responsibility within a reasonable time after graduation. The railroad will, of course, have the right to dispense with the services of any apprentice whose work or conduct is unsatisfactory. Neither do they agree to retain the men in their service after the completion of their apprenticeship. Work in these courses will be started in September of this year.

MARKING WHITE LINES ON BLUE PRINTS.—Add to a small bottle of water enough washing soda to make a clear white line, then add enough gum arabic to it to prevent spreading and making ragged lines. To make red lines dip the pen in red ink and then add a little of the solution by means of the quill.—*Ed. H. Remde, Machinery.*

50-TON STEEL UNDERFRAME GONDOLA CAR.

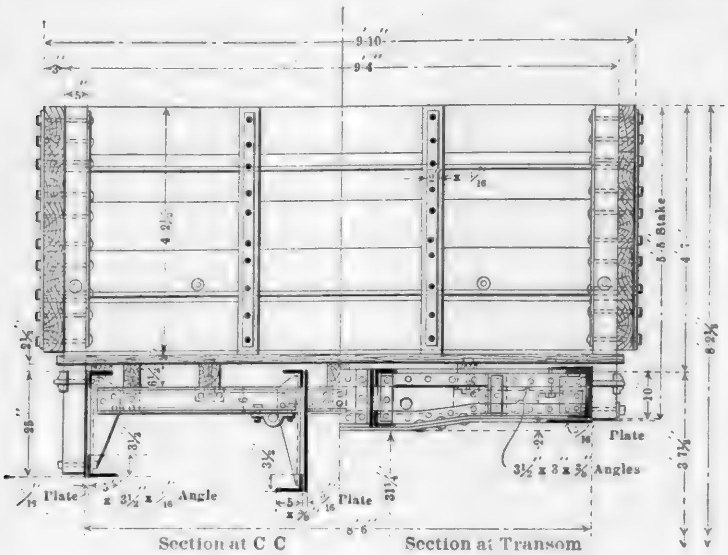
The Illinois Central Railroad has recently built at the Burnside shops 378 50-ton gondola cars with steel underframes furnished by the American Car & Foundry Company. These cars weigh 44,200 lbs. each and the inside dimensions are: Length, 41 ft. 9 ins.; width, 9 ft. 4 ins.; height, 4 ft. 2½ ins.

The centre sills between the bolsters consist of 5/16-in. steel plates with 5x3½x⅝-in. angles riveted at the top and bottom edge, as shown on the drawing. These sills are 25 ins. deep for a distance of about 10 ft. at the centre and taper to 12 ins. at the bolsters. The body bolster is built up of plates and angles and is continuous for the full width of the underframe. Two ⅜-in. plates spaced 6½ ins. apart have 3½x3x⅜-in. angles riveted at the top and bottom edges on the outside. These plates are 12 ins. deep at the centre and 10 ins. deep at the outer edge. Top and bottom cover plates, ¼ in. thick, stiffen the bolster and aid in securing it firmly to the sills. The web or plate member of the centre sills is attached to the bolster side-plate by two 5x3x⅜-in. angles, one on each side. The draft sills, 12-in. channels, 30 lbs. per foot, are attached to the body bolster in the same manner.

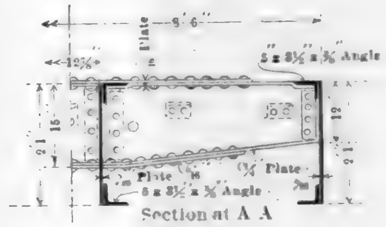
50-TON STEEL UNDERFRAME GONDOLA CAR—ILLINOIS CENTRAL RAILROAD.

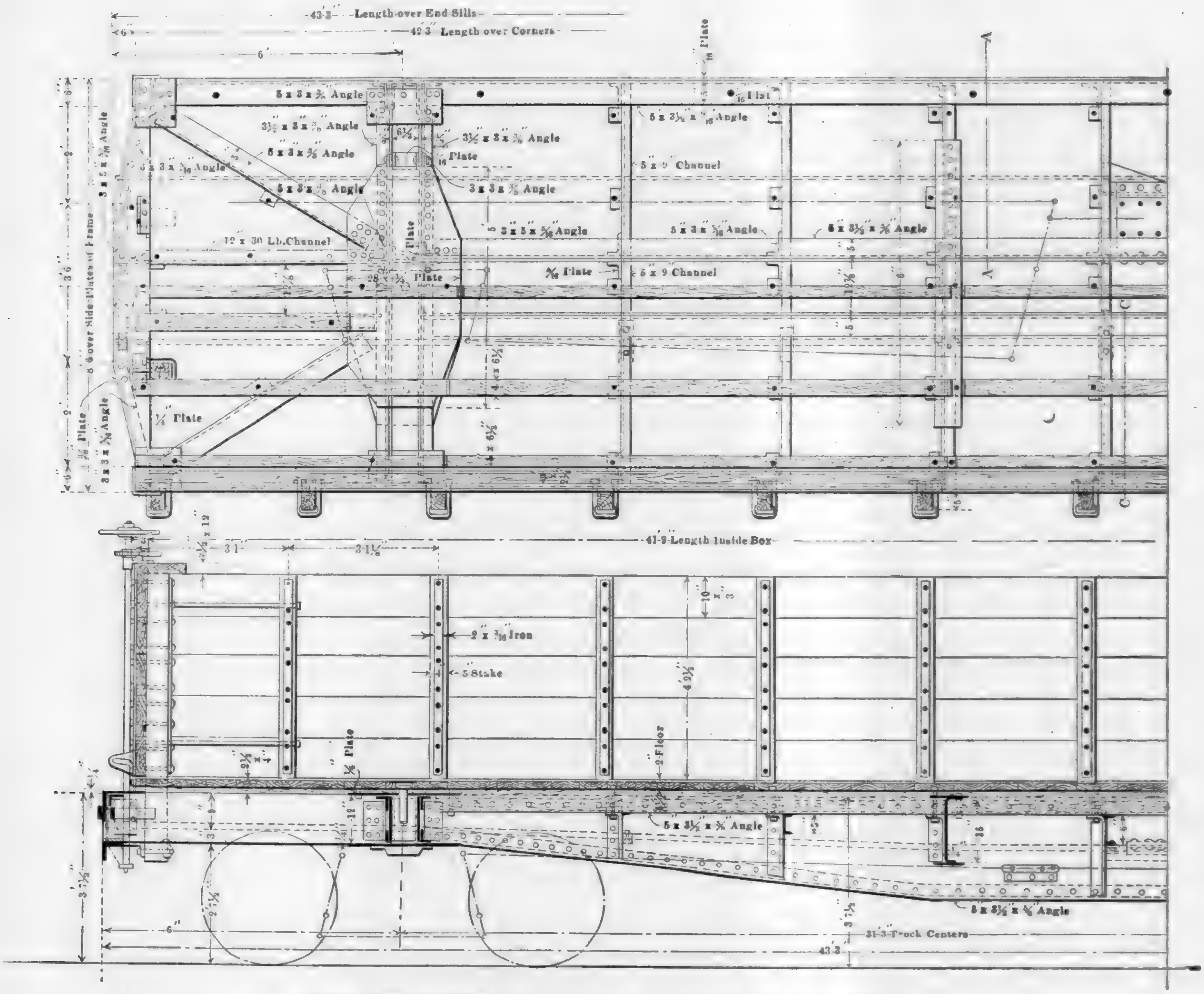
The side sills consist of a 5/16-in. steel plate with 5x3½x9/16-in. angles riveted at the top and bottom edges on the inside. These sills are practically of the same construction as the centre sills, but are continuous for the full length of the car. The ends of the bolster plates are attached to the side plates by the ⅜-in. U plate between the bolster plates and the 5x3x⅜-in. angles, as shown on the plan view. The end sills consist of ⅜-in. plate with 3x3x5½-in. angles riveted at both the top and bottom edges on the inside. The end sill plate is straight for a distance of 3 ft. 6 ins. at the centre of the car, and from this point slopes back 6 ins. to the corners. A ¼-in. plate, which is riveted to the top end sill angle, and also to the longitudinal sills, serves to stiffen the end of the car. The sills between the bolsters are tied together at frequent intervals by 6-in. channel plates, 10.5 lbs., near the centre of the car, and by 5-in., 9-lb., channels at other points. These are attached to the sills by angle plates, as shown. The stringers to which the floor planks are bolted are supported by these channels and are bolted to them. Two of the stiffeners, next to the two centre ones, consist of ¼-in. plate with flanges pressed at the top and bottom and tieing these stiffeners and the sills together are 5/16-in. top and bottom cover plates.

The side stakes are attached to the sills by a bolt near the bottom and a U bolt near the top of the sill. Four pairs of side stakes are tied by ¾-in. rods, which extend across the car. The sides and ends are placed outside of the stakes, giving the car a very neat appearance, and are bolted to them in the usual manner. The sides and ends of the car are tied at the corners by a ¼-in. angle plate on the outside and a 4x5-



POWER VS. ECONOMY.—Railroads are not operated to save fuel, nor to have locomotives that it does not cost much to maintain and operate, and while economy must be considered as secondary to getting trains over the line, at the same time, the tractive power required, and the limits given within which to acquire this, make it necessary that locomotives be now so designed and constructed that more work will be produced per unit of fuel consumed; and the result should be economy. Whether this economy can be derived from the use of turbine, internal combustion, pneumatic or electric loco-





50-TON STEEL UNDERFRAME GONDOLA CAR—ILLINOIS CENTRAL RAILROAD.

in. stake on the inside. The car is equipped with Susemihl side bearings and Ajax trucks. Three different types of draft rigging were used—Miner, Sessions and Farlow. We are indebted for drawings and information to Mr. J. H. Wynne, mechanical engineeer.

motives, or by a further practical development of the present type of steam locomotive, will depend entirely on the local conditions and requirements, and remains for the present and future progress to determine.—*Mr. Muhlfeld, New York Railroad Club.*

THE MELLIN COMPOUND.

By Hal R. Stafford.*

The four-cylinder balanced compound is absorbing so much of our attention to-day that we have had little time to study the progress of our old friend, the two-cylinder, or cross-compound; indeed, many of us may think it has had its day so little has been heard of it lately. True it is, that fewer of these engines have been put into service in the United States in the past year or so than in former times, but the Michigan Central and "Soo Line" with their "Schenectady" compounds, and the Grand Trunk, whose standard freight engine is the Mellin or "Richmond" compound, would refute the charge that this type is slipping into oblivion, to say nothing of the fact that the Mellin compound has long been the standard engine on the State Railways of Sweden, and in very recent tests with other advanced types, has proved its superiority against all comers. It is a significant fact that those roads which have had the longest experience with these engines are their strongest advocates. With them they have come to stay, having long passed the experimental stage.

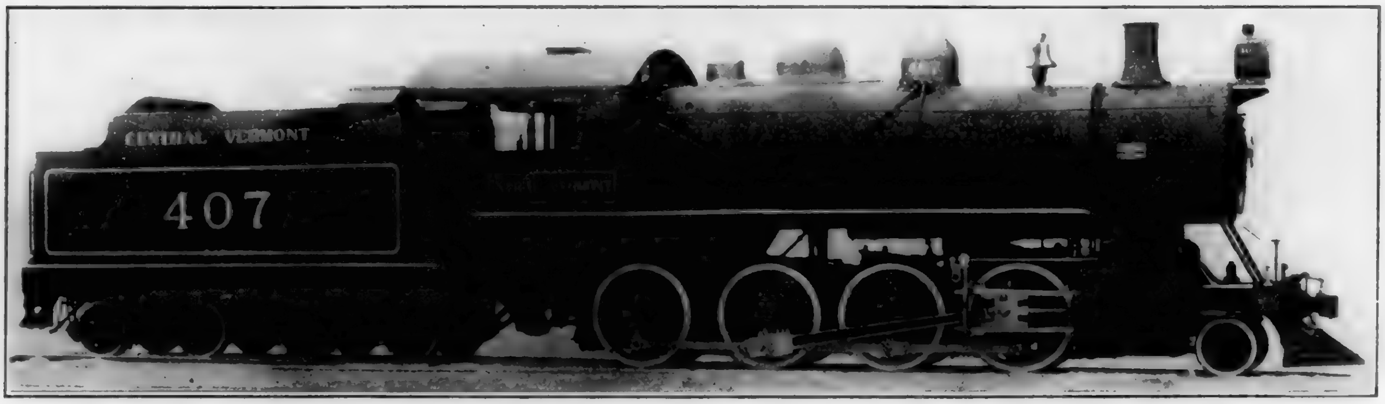


FIG. 1.—MELLIN COMPOUND CONSOLIDATION LOCOMOTIVE—CENTRAL VERMONT RAILWAY.

Weight, Total..................192,500 lbs.	Tractive Power ....38,700 lbs.	Boiler Pressure ....210 lbs.
Weight on Drivers............167,500 lbs.	Cylinders ....22½ and 35x32 in.	Diam., Drivers ....57 in.

We find, in the two-cylinder compound, the compound principle reduced to simplest terms—the same number of working parts as a simple engine, with only the addition of an intercepting valve and a pair of by-pass valves to the low-pressure cylinder, and these latter are no longer only to be found on the compound, but are coming to be regarded as a necessity on all piston valve simple engines. A little higher in first cost than a simple engine, its saving of 20 to 25 per cent. of the fuel bill soon cancels this debt; while the repair bill, long the bugbear of the motive power official, has actually proved to be less than for a simple engine, chiefly due to the saving in boiler work.†

The two-cylinder engine, in common with the other types of compound, lays claim to the advantage of large reserve power. The simple engine is cylindered to a certain factor of adhesion, say 4.5. More power than this it can never produce, even though under certain conditions, such as are met with on a severe curve when the rail elevation causes the flanges to bite the rail and thus increase adhesion, the factor might safely be reduced to a trifle over 3, thus increasing the hauling capacity on the ruling grade. The compound, on the other hand, makes use of this varying factor, and even in its normal working this can be much lower than on a simple engine, because of the more uniform turning moment due to a longer cutoff. In working simple the two-cylinder compound is less liable to slip than any other type, even though worked to its maximum; the reason will be explained in connection with the description of the Mellin system.

There are many mechanical advantages inherent in all two-cylinder compounds, over any other arrangement of cylinders in present use in this country, among them the fact that it has separate valve gears for high and low-pressure cylinders, enabling the cut-off and other events of steam distribution in one cylinder to be adjusted wholly independent of the other.

While this type has been used almost exclusively for freight service, there is every reason to believe that, with certain modifications, it might be applied successfully to passenger service. There are perfectly authentic records of an engine of the Mellin type, with 62-in. drivers, maintaining a speed of 65 miles per hour, necessitating a very high piston speed. This engine, in common with all of recent construction of this type, had improved Allen valves to the low-pressure cylinder, with considerable inside clearance, and the Allen port so modified as to enable it to act as an auxiliary exhaust port.

The Mellin or Richmond compound was one of the first successful two-cylinder compounds. The story of its introduction is interesting. In September, 1894, the Richmond Locomotive and Machine Works built an engine on the Mellin principle, embodying the experience gained in the construction of several previous engines, which engine afterwards became famous under the popular name of the "Tramp," because of its wide wanderings, having seen service in 34 States of the Union, on nearly every important road in the country. This engine was in most cases loaned gratuitously to any road desirous of investigating the merits of the compound engine, on the sole condition that the results, whether favorable or unfavorable to the compound, be made public. In most cases exhaustive tests were made in competition with "specially prepared" simple engines, and a record of the percentage of saving effected by compounding on the various lines, under various conditions, and varying degrees of prejudice, is interesting. The result was in every case favorable to the compound, the general average being a saving of coal of 26.1 per cent. and a saving of water of about 16 per cent. This famous engine is still in service, having been sold to a western road after being exhibited at the Pan-American Exposition.

Even after the famous cruise of the "Tramp," the compound had to be almost forced upon the conservative motive power world, and in many cases engines were sold for the price of a simple engine, and were made to pay their additional cost out of the saving effected, recalling the methods of George Corliss.

The Mellin system has seen little radical change since its adoption by the Grand Trunk in 1899, but a description of the machine in its latest form, as embodied in the engines lately built for the Central Vermont, and illustrated herewith, will no doubt be of interest.

Fig. 2 shows the arrangement of cylinders, the low-pressure on the right and the high-pressure on the left side of the engine, the section being taken through the receiver pipe connections, looking toward the back end. The small view

*American Locomotive Company, Schenectady, New York.

†See proceedings of Canadian Railway Club, meeting of Sept., 1904.

shows the facing for the intercepting valve head on the front of the saddle, and the outlet of the high-pressure steam passage "Y" in main view. High-pressure steam is brought from a pocket in connection with the steam pipe in the high-pressure cylinder to the low-pressure side by the bridge pipe "X" (former engines had a pipe leading from the T-head). The passage of steam from the dry pipe to the high-pressure cylinder, then through the receiver pipe to the intercepting valve and thence to the low-pressure cylinder can readily be traced on Fig. 2 by means of the arrows, so that we may turn our attention to the intercepting valve, which is the distinctive feature of the Mellin compound.

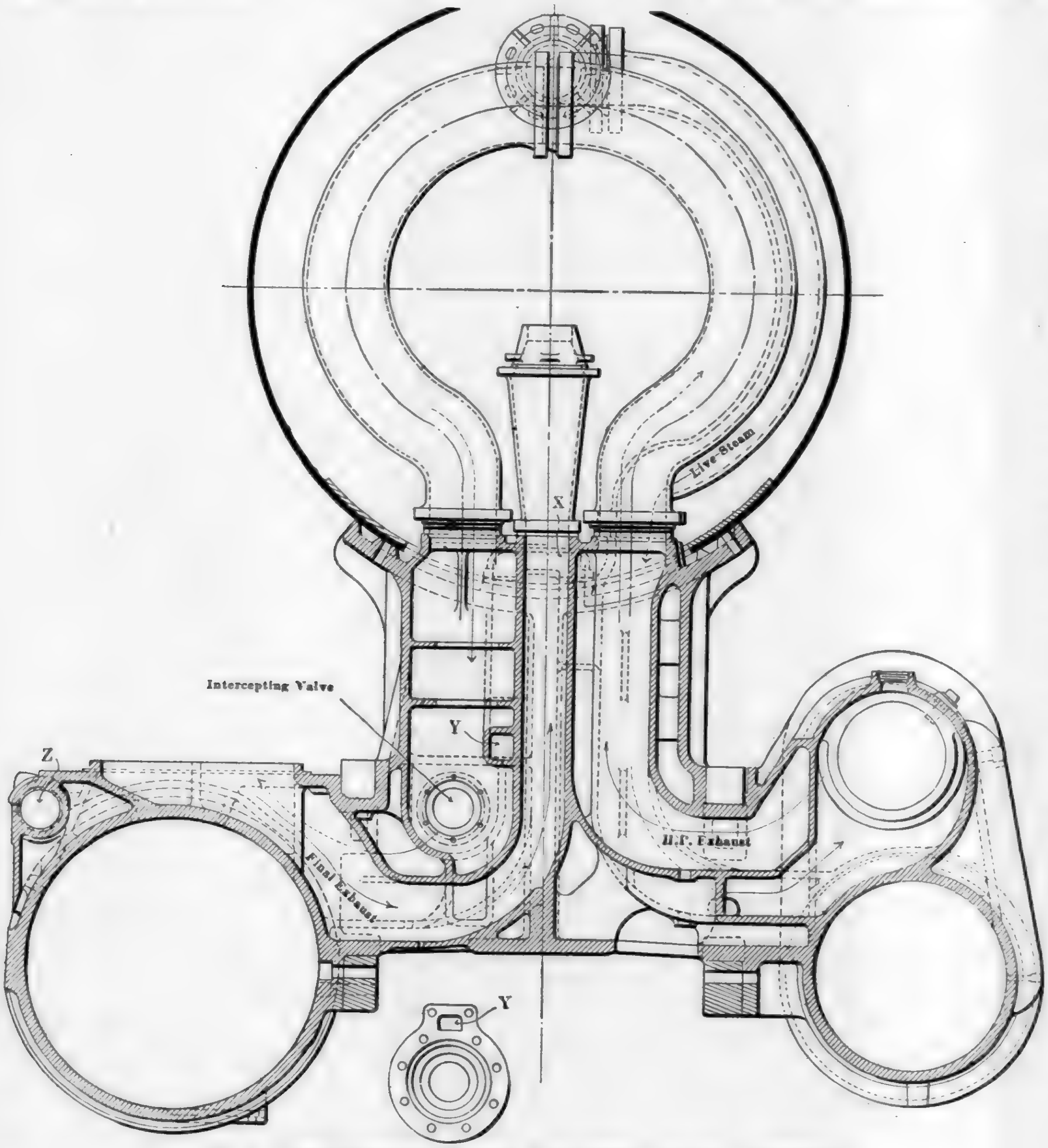


FIG. 2.—ARRANGEMENT OF THE CYLINDERS—MELLIN COMPOUND.

A glance at Fig. 3 will show a machinist that the machine work on this valve is all lathe work, except for the drilling of the holes in the cover, etc. There are no expensive operations requiring special skill or special machinery. A fairly good lathe hand can do the job and do it right the first time.

Its operation is as simple. In starting, live steam enters through the head, and passing into the port A, moves the reducing valve to the right by virtue of the difference in the areas "X" and "Y." The point B engaging with the shoulder on the main stem, closes the intercepting valve and at the same time live steam enters through the reducing valve. After a few revolutions sufficient pressure is accumulated by the exhaust of the high-pressure cylinder at the right of the main valve to force it open against the pressure of the live steam on the differential area of the reducing valve. This opens the intercepting valve and at the same time closes the reducing valve. The engine is then working compound. The reducing valve being loose on the stem of the main valve, is capable of sufficient movement to close the live steam inlet independent of the movement of the main valve, thus working as an ordinary differential reducing valve to restrict the pressure in the low-pressure cylinder to the amount determined upon in equalizing the work of the two cylinders.

In case it is desired to work the engine simple for a longer period in starting, the emergency exhaust valve is opened by admitting steam behind the piston C—a three-way cock within easy reach of the engineer performs this function—which allows the exhaust from the high-pressure cylinder to escape to the atmosphere and prevents the accumulation of pressure behind the main valve. In changing from compound to simple, the balancing piston and chamber, features peculiar to the Mellin compound, come into play. The balancing chamber D is of small volume and is completely cut off from communication with other passages except as shown. It is open to the receiver through six ¾-in. holes in the balancing piston, which ordinarily suffice to equalize the pressure between them. But upon opening the emergency exhaust valve this chamber is emptied more rapidly than the area of these holes can supply it, with the result that the intercepting valve is closed instantly by the pressure on the balancing piston. This prevents the loss of pressure in the receiver which would be necessary to close the valve in the ordinary manner, and avoids a drop in the power of the engine right at the "sticking point."

The air dash pot, at the extreme left of the drawing, needs no explanation. It is only meant to prevent slamming of the valve during closing, as the action of the valve during opening is very moderate—generally in two or three impulses.

The following formula may be used to determine the pressure in the receiver when working simple, or reducing valve pressure, which we will represent by p, and the receiver pressure required to open the main valve, or p_1.

Let a = area at Y (Fig. 3).
Let b = area at X
Let c = area at Z
Let P = boiler pressure.

Then

$$\frac{P\,(a-b)}{a-c} = p \text{ and } \frac{P\,(a-b)}{a} = p_1$$

The ratio of cylinder volumes, in the Mellin system is made 2½ to 1, as nearly as may be, keeping the diameters to the nearest ½ in. The most delicate problem in designing a two-cylinder compound is to equalize the work between the high and low-pressure sides under varying conditions. This is done by carefully adjusting the lap of the valves, and while

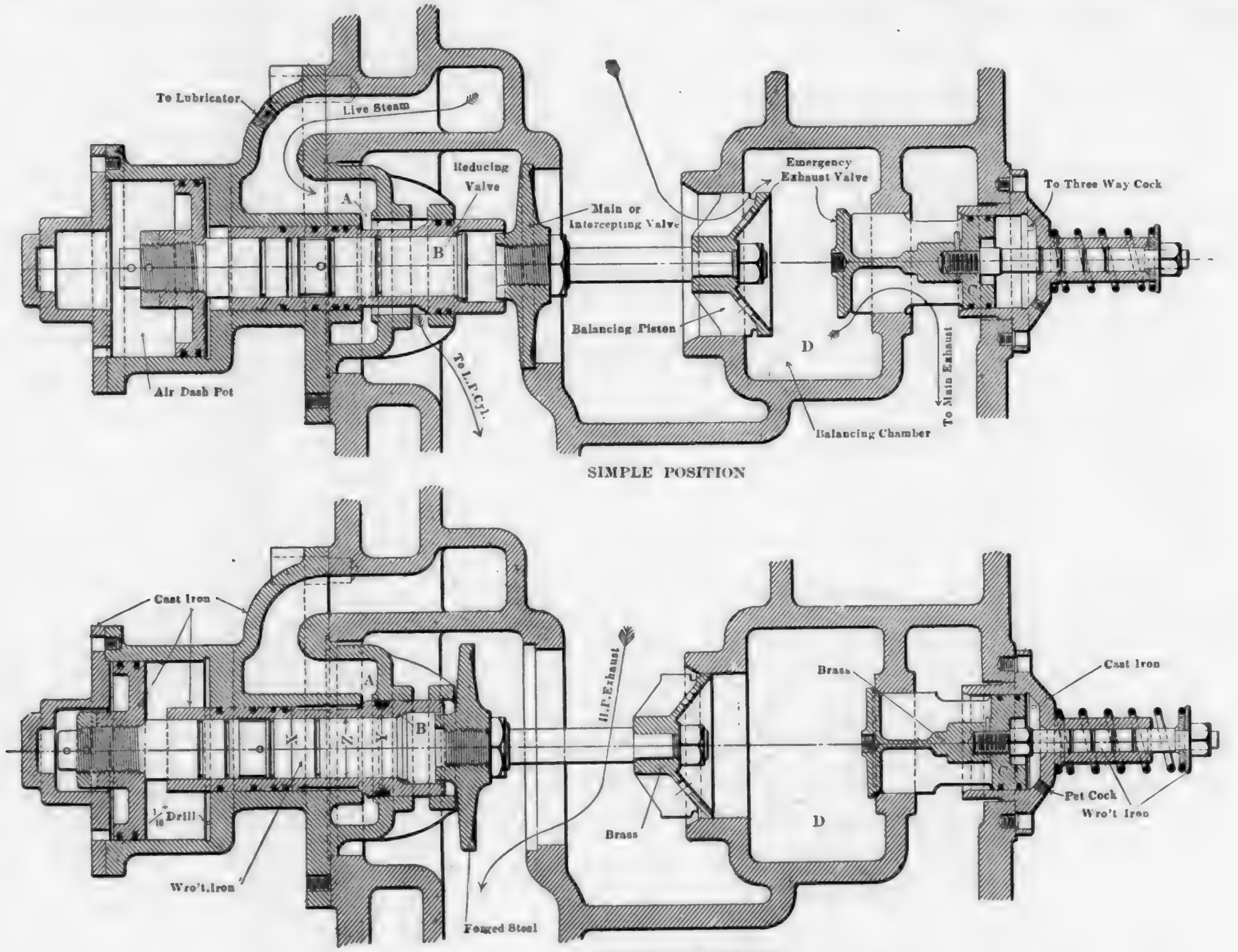


FIG. 3.—INTERCEPTING VALVE—MELLIN COMPOUND.

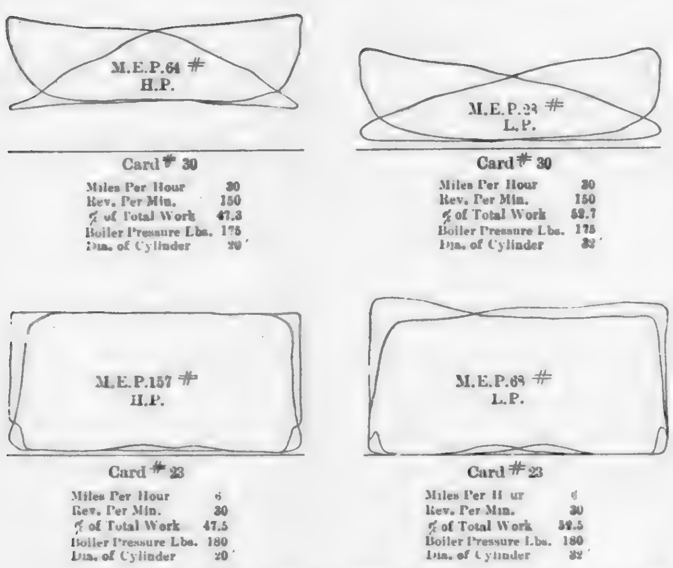


FIG. 4.—INDICATOR CARDS FROM MELLIN COMPOUND, 4—6—0 TYPE FREIGHT ENGINE—C. C. C. & ST. L. R. R.

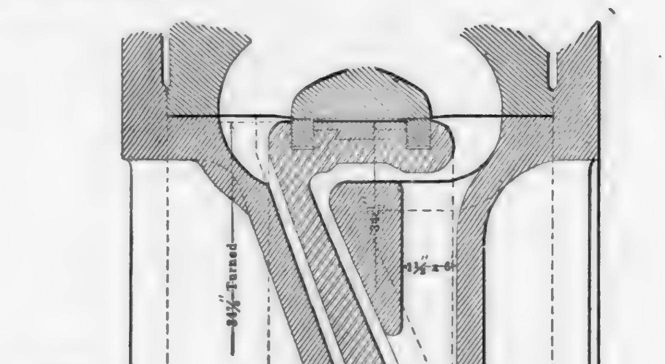


FIG. 6.—LOW-PRESSURE PISTON AND CYLINDER HEADS.

the result can only be approximate, the closeness of the approximation may be judged from the indicator cards shown in Fig. 4, which were chosen at random from a set taken from engine number 350 on the "Big Four" in 1897. The cards taken during this test show a maximum variation of about 4 per cent. either way from exact equalization, both in simple and compound position. That may be called near enough, since we may get a difference of 25 per cent. in a simple engine, by mere variation in lubrication! In general,

less attention is given to equalizing the work in the simple position than in the compound, since this is an abnormal condition, as is conveyed by the word "emergency"—applied to the simpling valve.

The experience of builders and users of compound engines has taught them that for the present at least the engineer must be prevented from using the simpling valve unnecessarily, by some other means than persuasion. He soon finds that, under certain conditions, the opening of the three-way cock has the same result as of "another engine pushing from behind," and in his laudable zeal to get over the road, his hand seeks the little brass lever too often for the good of the coal pile. For this reason the area of the reducing valve, a—b in the formula, is purposely restricted, so that above a certain speed—about 10 miles per hour—the wire-drawing of steam through this opening so reduces the receiver pressure

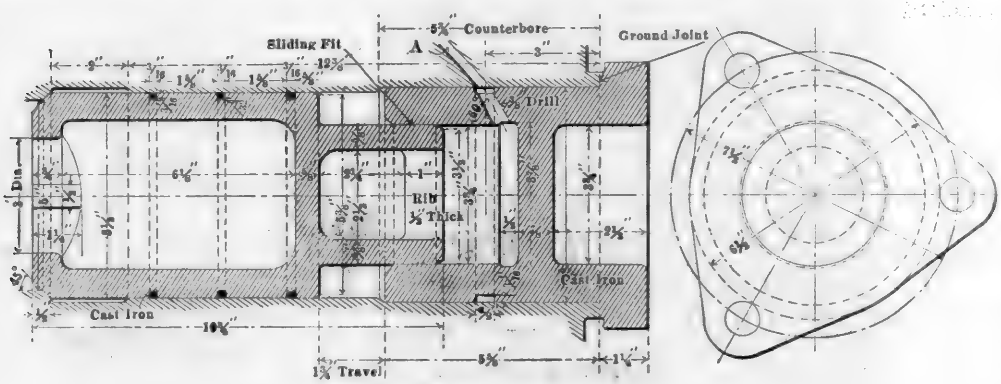


FIG 5.—BY-PASS VALVE.

as to make further acceleration impossible without going into compound. The restriction of this area fulfils another purpose, that of preventing the slipping of drivers when working simple by this same wire-drawing effect, as soon as the low-pressure piston begins to travel at undue speed, as in slipping.

The office of the by-pass valves, Fig. 5, used only on the low-pressure cylinder, is so well understood as to need little explanation. In drifting, the effect of so large a piston acting as an air pump to force air through the exhaust pipe is to create nearly as good a draft as when working steam; moreover, the work thus expended on one side of the engine, with its vertical disturbing forces due to the angularity of the main rod, makes a hard riding engine when drifting down grade at high speed. To do away with these undesirable features is the purpose of the by-pass valve.* A pair of these are placed in the chamber "Z," Fig. 3, one closing each port, with a passage 5 ins. in diameter connecting the two. The hole "A," Fig. 5, being in communication with the steam chest, the pressure therein, when working steam, keeps these valves closed. But on shutting the throttle, a partial vacuum is soon formed in the chest, which acts on the ends of the valves, causing them to open and establish direct communication between the opposite ends of the cylinder. The action of these valves is so satisfactory that they have been extensively copied in foreign countries.

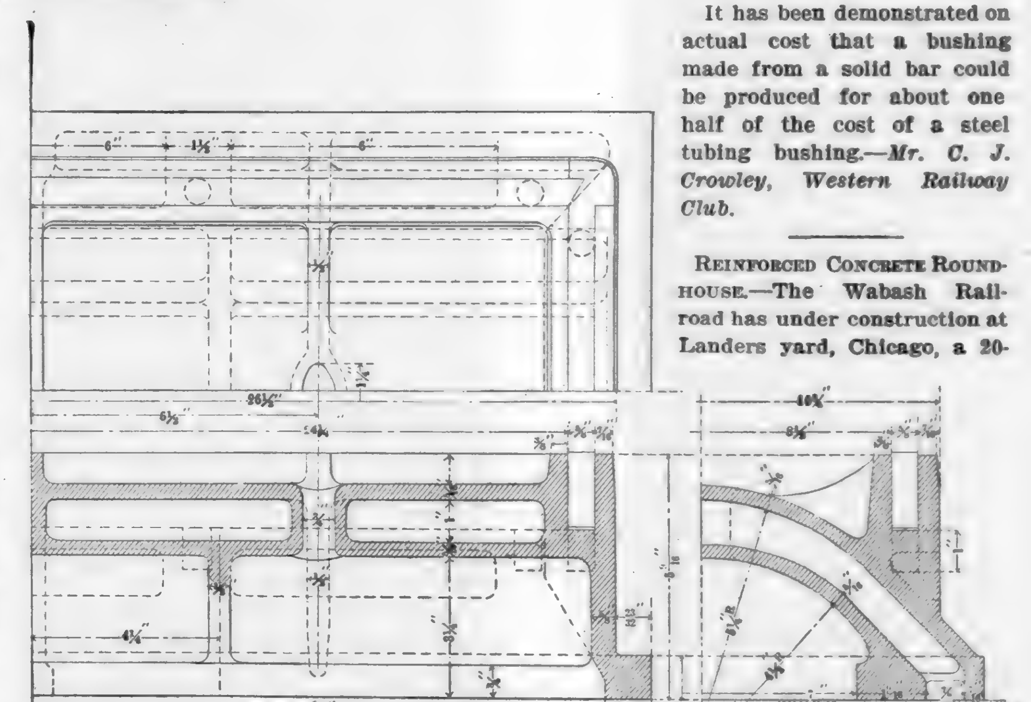


FIG. 7.—LOW-PRESSURE VALVE.

*See *Railroad Gazette*, Jan. 25, 1901, "Progress of Two-Cylinder Compound Locomotives."

Drawings are shown of the low-pressure cylinder heads and piston, which have some original features; and the low-pressure valve, showing the liberal exhaust clearance; also the Allen port clearance—this port is usually made line and line with the edge of the steam port on other engines.

The engine-man requires little special knowledge to handle this engine—he will be glad to learn the use of the lever which will help him over the hard spots. All else he will need to know, provided he is familiar with the simple engine, is that a cross-compound may also be disconnected and brought in on one side, but he must always remember *to open the emergency valve* in either case, whether the disabled side be high or low pressure. He will soon learn of his own accord when it will help to simple his engine, and when it will do no good.

In conclusion, we would like to call the attention of those who say that the capacity for growth of the two-cylinder compound is limited by the size of the low-pressure cylinder, that the limit is at least a liberal one, and comes near the point where we begin to meet with other limitations. We refer to the table giving the principal dimensions of the engines for the Central Vermont, illustrated at the beginning of this article, on which the new power for the Grand Trunk, now building, is based.

It has been demonstrated on actual cost that a bushing made from a solid bar could be produced for about one half of the cost of a steel tubing bushing.—*Mr. C. J. Crowley, Western Railway Club.*

Reinforced Concrete Roundhouse.—The Wabash Railroad has under construction at Landers yard, Chicago, a 20-stall roundhouse, the outer and end walls of which are of reinforced concrete. The engine pit walls are of plain concrete and the pit floor is of paving brick laid on edge on a sand bed and grouted. The house is 81 ft. 6 ins. deep; the transverse roof timbers are supported by three intermediate posts, 10 x 10 ins., in addition to the outer wall support and the column or door post at the inner wall.

The Interborough Rapid Transit Co., of New York City, is said to be carrying an average of 1,250,000 passengers a day.

One result of extensive water softening is to very greatly decrease the cost of roundhouse repairs.

VALUABLE ADVICE TO COLLEGE MEN.

Mr. H. W. Jacobs, engineer of shop methods and tools of the Atchison, Topeka & Santa Fe Railway, recently delivered an address before the engineering students of the University of Kansas, at Lawrence, Kan., which was exceedingly valuable, not alone to college men, but to all those who are interested in railway shop methods, and we regret that we are not able to reproduce a greater portion of it. At the beginning of the talk Mr. Jacobs gave some splendid advice to the students as follows:

"In the past few years an entirely new profession has developed, known as commercial engineering, brought about by the keen competition of manufacturers. The engineer of today who is not able to take hold of a proposition and figure results from a business standpoint is likely to be left at the post. The Panama Canal is not being built as a triumphal exploit of engineering skill, but because it will cheapen the cost of ocean transportation; the Lucien Cut-off on the Southern Pacific, with its thirteen miles of trestle work over Great Salt Lake, although it represents the acme of achievement in railroad construction, was not built as a scientific experiment, but was brought about because by this method Oriental freight could be put from San Francisco into the Eastern markets at so much less per ton.

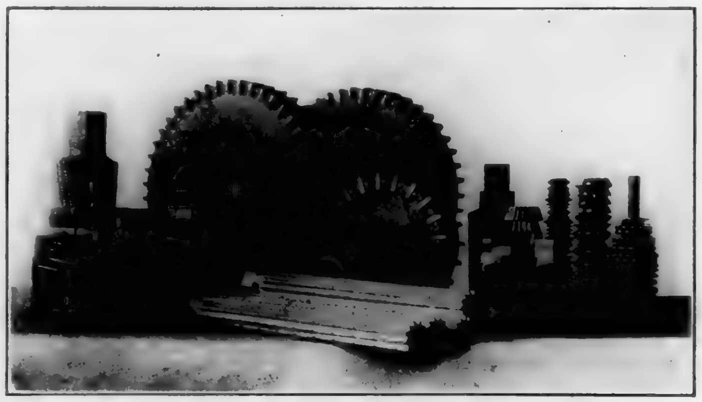
"This is the great and, in fact, the only idea for any young man to keep in mind when leaving college and starting in for himself. The majority of men within my hearing to-day will, no doubt, on the completion of their college course, find their way into the employ of some factory, railroad shop, steel mill, bridge works, or some manufacturing concern. The question will be, then (if the young man intends to make his mark), not how nicely can he sketch a plan on a piece of tracing cloth, or how clearly can he elucidate upon the many theories of applied mechanics, but how much of a saving can he show in shop management, how much can he cheapen the production of some particular article? What can he do to help tone up the plant so that the best results can be obtained from his particular department? These are the problems he will have before him, and these only must be kept in mind if he expects to make a showing worthy of note, and of sufficient importance to attract the attention of the head of the concern.

"Among practical, everyday shop men the average technical graduate is given very little consideration. This, of course, may be the misfortune of the shop men or it may be the effect of the attitude of the graduate. The fact remains that there is a great deal of truth in the statement. In nine cases out of ten when a technical graduate secures a position in a shop of any kind he is considered of about as much use as an ordinary helper, or he is classed under the rather ambiguous title of special apprentice, and duties are assigned to him in about the same proportion. The graduates themselves, in my experience, are greatly responsible for this state of affairs. They enter a shop knowing almost to a certainty that this exists, yet in many instances they make no effort to change the general opinion. They take hold of the work that is given them in a rather perfunctory manner, and seem incapable, in many cases, of developing ideas on the subject at hand, and in a short time they find themselves moving in the same old rut of shop routine that may have existed ever since the shop was built. Instead of keeping their eyes open for chances for improvements and taking them up in the proper manner, they are content to allow things to drag along with as much unconcern as if they had never been blessed with advantages of any kind.

"This is the point that I want to impress on your minds: *Be on the lookout for improvements in methods of all kinds at all times.* Don't think for a moment that I am decrying mechanical training simply because a great many of the graduates have made seeming failures. The trained men are the men that are needed; the technical men are the men that have to fill the important places in all cases. They must be the pioneers!

"The theories of to-day become the practices of to-morrow, and the men who can look ahead and anticipate a demand are the men that are going to win in the long run. Have a systematic line of investigation that you intend to carry out if ever you enter a shop, no matter what may be its kind of output. Keep the cost of production ever in your mind, and let no chance escape you if you see an opening of any kind for improvement.

"If you enter a machine shop don't be content with doing whatever little detail you may be assigned to on some particular bench or machine. Note the entire layout of the plant. See what kind of power they are using. Note the method of transmission. Keep an eye on the class of machines in service; also their condition. Check up the speeds of shafting at the first opportunity. Note the method of making tools. Read up on tool steels. Keep in touch with the newest and latest catalogs on machinery. Compare the methods with other shops. Check the price lists of similar articles made in other parts of the country. In fact, familiarize yourself with every item of interest in any way connected with the article in question. You will be surprised how soon you are noted by some official of the organization. I have had too many years of actual experience in shop work not to know that I am speaking the exact truth. If you are in the designing department, don't put in your time seeing how nice a set of lines you can embellish with graceful curves, but see how much machine work you can eliminate in the assembling room. This is very essential: No one will deny that the sale of any article, no matter what it may be, is very greatly affected by its general appearance. It must look neat, as well as be reliable, but the days of elaborate finish are past.



MILLING CUTTERS, REAMERS AND HIGH-SPEED TOOLS MANUFACTURED ECONOMICALLY IN A RAILROAD SHOP TOOL ROOM.

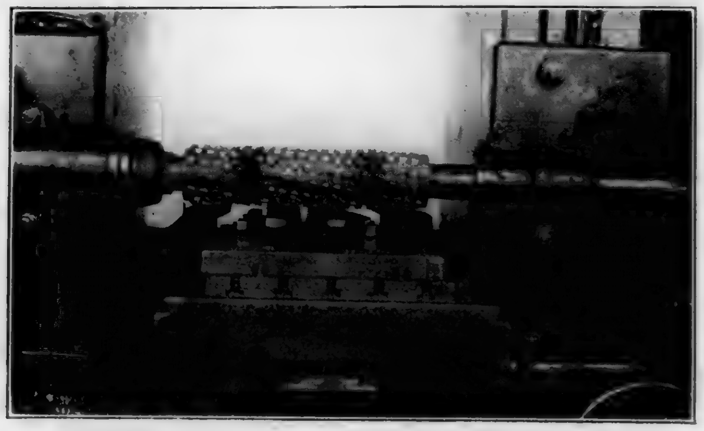
"There was a day when buildings were equipped with heavy trappings of all descriptions and locomotives were encircled with rings of polished brass, but the best sellers of all merchantable articles to-day are those of the plainest finish.

"It is not how nice does a locomotive look to-day; it is how many tons can it haul. It is not what sort of a polish do you have on your line shaft; it is how many revolutions can it make a minute. It is not what style of architecture is your furnace built in; it is how many tons of pig iron can it turn out in twenty-four hours.

"I believe, however, I have talked long enough on generalities, and I think, perhaps, I could demonstrate to you much more clearly with the following illustrations, than I could explain otherwise what I mean when I speak of 'toning up a plant.'"

After this introductory address about 150 lantern slides were shown illustrative of these methods of "toning up" as applied to railway shop work. The first group of slides dealt with the general lay-out and of material storage and handling arrangements of a large shop. The next group dealt with the methods of improving machine belting, this being one of the first points to be taken up when shop betterment is undertaken, as by this alone the efficiency of the machines will be increased as a whole from 10 to 30 per cent. The third series showed the changes in shop methods, machine tools and de-

vices, incident to the use of the new high-speed alloy tool steels developed since the introduction of the Taylor-White process. After these were shown some views of machine betterments necessitated by the intensive shop production due to the use of these high-speed heavy service tools, such as the substitution of steel for cast iron gears, the increase in size of driving and feed pulleys and gears, the strengthening of steady rests, housings, etc. Then followed illustrations of a number of



IMPROVED METHOD OF MILLING FOUR ROWS OF SHOES AT ONE TIME.

special devices for use in railway shops, showing how, by the exercise of a little ingenuity in the tool room, the cost of machining many special locomotive parts could be greatly reduced.

Next after these were shown special jigs for use on the machines, and then followed a long series of slides on the subject of tool standardization for an entire railway system, i. e., standardizing punches, drills, reamers for crosshead, knuckle pin, and ball joint work, flue rollers, etc. A number of views were then given of a recent very light air motor that has many advantages for work in close quarters, and on account

LARGE COMPOUND MILLING CUTTER FOR FINISHING SEVEN SURFACES AT ONE TIME.

of its efficiency. Following these, various devices for use in erecting floor work were shown, cylinder boring machine, valve facing device, a convenient portable air hoist for main air reservoirs on engines, guide lining device, valve bushing extractor, etc. Mr. Jacobs concluded his address with a very interesting description of the individual effort system (See AMERICAN ENGINEER AND RAILROAD JOURNAL, February, 1906, page 61), for rewarding labor as applied in a large shop to effect economical production and to reduce to a satisfactory basis the wage problem.

Correspondence is one source of delay, and if it can be cut down in any department, the service is benefited.—*Sydney Gilliard, Pacific Coast Railway Club.*

LIGHTING MACHINE TOOLS.

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It isn't necessary to employ an illuminating engineer to place lamps properly about a shop. All that is required is to give the workmen to understand that the lamps will be fixed for them as they may desire. If such a hint was given them and their wishes were then followed, in many shops much more satisfactory machine work would be turned out, and it would be executed much more rapidly.—*Street Railroad Journal.*

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VALUABLE ADVICE TO COLLEGE MEN.

Mr. H. W. Jacobs, engineer of shop methods and tools of the Atchison, Topeka & Santa Fe Railway, recently delivered an address before the engineering students of the University of Kansas, at Lawrence, Kan., which was exceedingly valuable, not alone to college men, but to all those who are interested in railway shop methods, and we regret that we are not able to reproduce a greater portion of it. At the beginning of the talk Mr. Jacobs gave some splendid advice to the students as follows:

"In the past few years an entirely new profession has developed, known as commercial engineering, brought about by the keen competition of manufacturers. The engineer of to day who is not able to take hold of a proposition and figure results from a business standpoint is likely to be left at the post. The Panama Canal is not being built as a triumphal exploit of engineering skill, but because it will cheapen the cost of ocean transportation; the Lucien Cut-off on the Southern Pacific, with its thirteen miles of trestle work over Great Salt Lake, although it represents the acme of achievement in railroad construction, was not built as a scientific experiment, but was brought about because by this method Oriental freight could be put from San Francisco into the Eastern markets at so much less per ton.

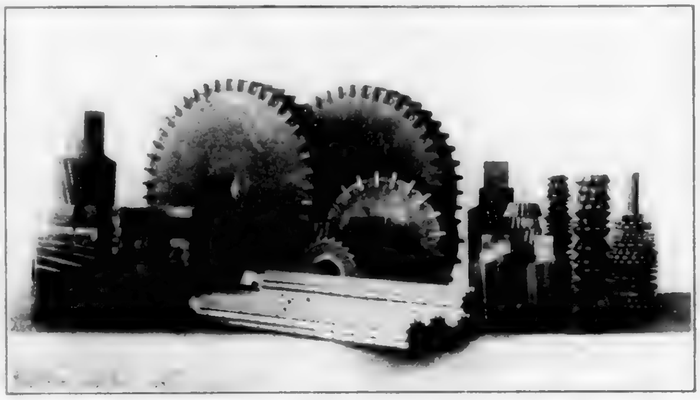
"This is the great and, in fact, the only idea for any young man to keep in mind when leaving college and starting in for himself. The majority of men within my hearing to day will, no doubt, on the completion of their college course, find their way into the employ of some factory, railroad shop, steel mill, bridge works, or some manufacturing concern. The question will be, then (if the young man intends to make his mark), not how nicely can he sketch a plan on a piece of tracing cloth, or how clearly can he elucidate upon the many theories of applied mechanics, but how much of a saving can he show in shop management, how much can he cheapen the production of some particular article? What can he do to help tone up the plant so that the best results can be obtained from his particular department? These are the problems he will have before him, and these only must be kept in mind if he expects to make a showing worthy of note, and of sufficient importance to attract the attention of the head of the concern.

"Among practical, everyday shop men the average technical graduate is given very little consideration. This, of course, may be the misfortune of the shop men or it may be the effect of the attitude of the graduate. The fact remains that there is a great deal of truth in the statement. In nine cases out of ten when a technical graduate secures a position in a shop of any kind he is considered of about as much use as an ordinary helper, or he is classed under the rather ambiguous title of special apprentice, and duties are assigned to him in about the same proportion. The graduates themselves, in my experience, are greatly responsible for this state of affairs. They enter a shop knowing almost to a certainty that this exists, yet in many instances they make no effort to change the general opinion. They take hold of the work that is given them in a rather perfunctory manner, and seem incapable, in many cases, of developing ideas on the subject at hand, and in a short time they find themselves moving in the same old rut of shop routine that may have existed ever since the shop was built. Instead of keeping their eyes open for chances for improvements and taking them up in the proper manner, they are content to allow things to drag along with as much unconcern as if they had never been blessed with advantages of any kind.

"This is the point that I want to impress on your minds: *Be on the lookout for improvements in methods of all kinds at all times.* Don't think for a moment that I am decrying mechanical training simply because a great many of the graduates have made seeming failures. The trained men are the men that are needed; the technical men are the men that have to fill the important places in all cases. They must be the pioneers!

"The theories of to-day become the practices of to-morrow, and the men who can look ahead and anticipate a demand are the men that are going to win in the long run. Have a systematic line of investigation that you intend to carry out if ever you enter a shop, no matter what may be its kind of output. Keep the cost of production ever in your mind, and let no chance escape you if you see an opening of any kind for improvement.

"If you enter a machine shop don't be content with doing whatever little detail you may be assigned to on some particular bench or machine. Note the entire layout of the plant. See what kind of power they are using. Note the method of transmission. Keep an eye on the class of machines in service; also their condition. Check up the speeds of shafting at the first opportunity. Note the method of making tools. Read up on tool steels. Keep in touch with the newest and latest catalogs on machinery. Compare the methods with other shops. Check the price lists of similar articles made in other parts of the country. In fact, familiarize yourself with every item of interest in any way connected with the article in question. You will be surprised how soon you are noted by some official of the organization. I have had too many years of actual experience in shop work not to know that I am speaking the exact truth. If you are in the designing department, don't put in your time seeing how nice a set of lines you can embellish with graceful curves, but see how much machine work you can eliminate in the assembling room. This is very essential: No one will deny that the sale of any article, no matter what it may be, is very greatly affected by its general appearance. It must look neat, as well as be reliable, but the days of elaborate finish are past.



MILLING CUTTERS, REAMERS AND HIGH-SPEED TOOLS MANUFACTURED ECONOMICALLY IN A RAILROAD SHOP TOOL ROOM.

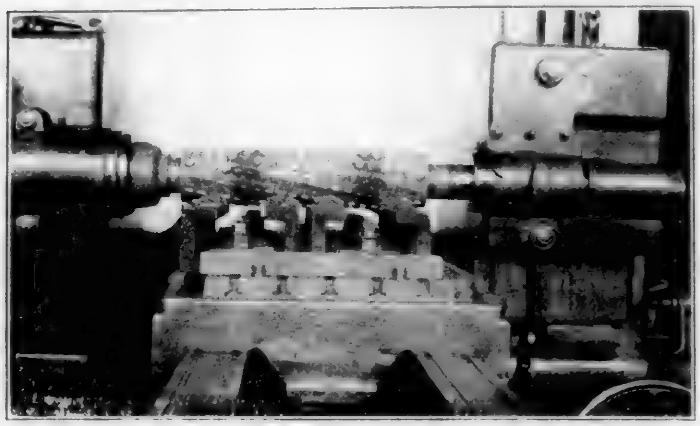
"There was a day when buildings were equipped with heavy trappings of all descriptions and locomotives were encircled with rings of polished brass, but the best sellers of all merchantable articles to-day are those of the plainest finish.

"It is not how nice does a locomotive look to-day; it is how many tons can it haul. It is not what sort of a polish do you have on your line shaft; it is how many revolutions can it make a minute. It is not what style of architecture is your furnace built in; it is how many tons of pig iron can it turn out in twenty-four hours.

"I believe, however, I have talked long enough on generalities, and I think, perhaps, I could demonstrate to you much more clearly with the following illustrations, than I could explain otherwise what I mean when I speak of 'toning up a plant.'"

After this introductory address about 150 lantern slides were shown illustrative of these methods of "toning up" as applied to railway shop work. The first group of slides dealt with the general lay-out and of material storage and handling arrangements of a large shop. The next group dealt with the methods of improving machine belting, this being one of the first points to be taken up when shop betterment is undertaken, as by this alone the efficiency of the machines will be increased as a whole from 10 to 30 per cent. The third series showed the changes in shop methods, machine tools and de-

ices, incident to the use of the new high-speed alloy tool steels developed since the introduction of the Taylor-White process. After these were shown some views of machine betterments necessitated by the intensive shop production due to the use of these high-speed heavy service tools, such as the substitution of steel for cast iron gears, the increase in size of driving and feed pulleys and gears, the strengthening of steady rests, housings, etc. Then followed illustrations of a number of



IMPROVED METHOD OF MILLING FOUR ROWS OF SHOES AT ONE TIME.

special devices for use in railway shops, showing how, by the exercise of a little ingenuity in the tool room, the cost of machining many special locomotive parts could be greatly reduced.

Next after these were shown special jigs for use on the machines, and then followed a long series of slides on the subject of tool standardization for an entire railway system, i. e., standardizing punches, drills, reamers for crosshead, knuckle pin, and ball joint work, flue rollers, etc. A number of views were then given of a recent very light air motor that has many advantages for work in close quarters, and on account

LARGE COMPOUND MILLING CUTTER FOR FINISHING SEVEN SURFACES AT ONE TIME.

of its efficiency. Following these, various devices for use in erecting floor work were shown, cylinder boring machine, valve facing device, a convenient portable air hoist for main air reservoirs on engines, guide lining device, valve bushing extractor, etc. Mr. Jacobs concluded his address with a very interesting description of the individual effort system (See AMERICAN ENGINEER AND RAILROAD JOURNAL, February, 1906, page 61), for rewarding labor as applied in a large shop to effect economical production and to reduce to a satisfactory basis the wage problem.

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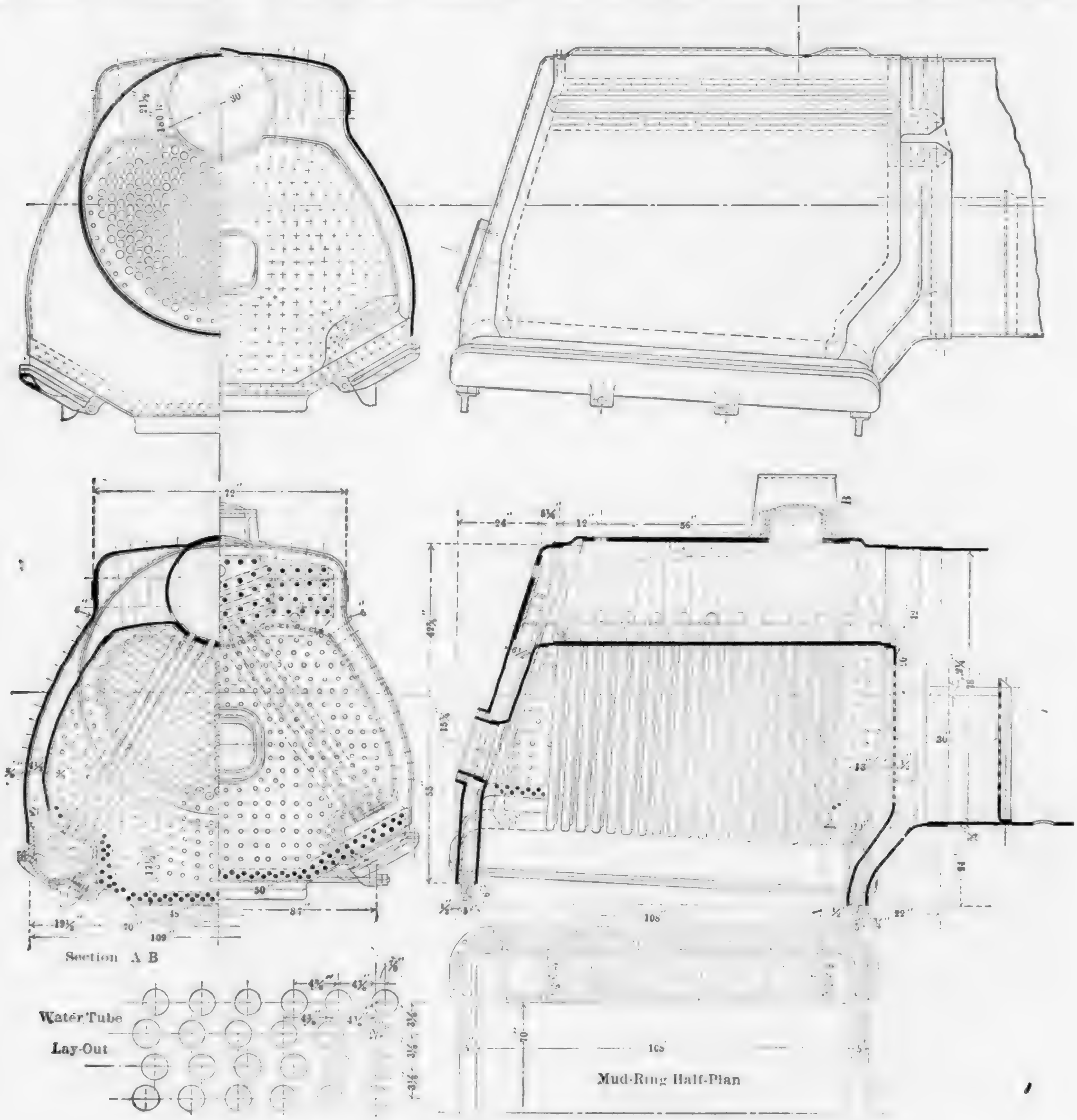
RIEGEL WATER TUBE LOCOMOTIVE BOILER.

The illustrations herewith show a new design of locomotive boiler which is arranged to take advantage, as far as possible without completely revolutionizing the present construction, of the advantages of the water tube method of steam generation. This boiler was designed by Mr. S. S. Riegel, who furnishes us with the following description of it:

Water in rapid circulation, over intensely heated surfaces, will absorb approximately five times the heat absorbed by sorbed rather than heat developed that generates the steam, it is equally important that the boiler be a generator as well as a furnace.

It is established that, in general, the most efficient generator is the one that has a good, definite and active circulation of the water over the heating surfaces and which has its heating surfaces located in the right place.

With the object of providing definite cycles of circulation of water over the heating surfaces and of locating these surfaces in the best possible places, rather than to provide a



RIEGEL WATER-TUBE FIREBOX FOR LOCOMOTIVE BOILERS.

water not in circulation, or of which the circulation is restricted, and we learn from the experiment of others that fuel burned at a normal rate will develop double the quantity of heat we may expect from it at a high rate of combustion.

It is maintained that the rate of combustion is so high and the passage of the heat from the grates to the stack is so rapid that, during the interval of time required in transit over this course, only a small part of it can be absorbed by the water; in other words, we are forcing our boilers beyond their capacity of heat absorption, and as it is quantity of heat ab-

greatly increased heating surface in the boiler, the design shown in the illustrations has been chosen.

It consists of a combination of water tubes with the flue boiler, and is, in brief, a re-design of the firebox.

The mud ring is made of cast-steel and has water-pockets cast in it at the sides beyond the grates, throughout its length, thus forming lower terminations for two nests of water tubes which extend from them diagonally upwards to the crown-sheet, which is slightly depressed to keep the upper tube terminations flooded. The water-pockets have staying ribs cast

integral with them, and the ribs are provided with holes to permit freedom of circulation.

The water-pockets are covered over at the bottom by removable plates to provide openings through which the tubes can be inserted and expanded, and through which the boiler can be easily examined and the tubes cleaned. The plates are hinged forward and back so they will swing back out of the way when the bolts which secure them in place are removed and so they can be swung back into position by a few men, thus avoiding the necessity of lifting them into place. The steam joints are made with sheets of soft metal.

The water tubes are so spaced that it is possible to pass a boring bar between them in order to remove defective staybolts, and they are kept sufficient distances from the flue, door and side sheets for accessibility for inspection and repairs.

The steam space is of the Belpaire type, for greater steam capacity and for simplicity of staying. Above the crown-sheet is provided a staying cylinder which, with the crown-sheet, makes double thickness at the crown for tube ends. This cylinder has sufficient flexibility to take care of expansion and contraction. Above the crown-sheet in the roof of the boiler is provided a combination manhole and pop-valve turret. This provides a ready means of access for inspection. The usual fire-brick arch is placed forward in the firebox; this diverts the gases and causes them to pass between the water tubes and impinge upon the side sheets. The gases which have been cooled by striking the water tubes are re-heated by the gases which pass around the nests of tubes and over the arch. In this way the heat is made to linger in the firebox, which, together with the increased circulation, gives the water a chance to take it up.

The illustrations show a re-design of the boiler of the Southern Railway Pacific type fast passenger engine with a dome course of 79½-ins. diameter. The grate area is approximately as before, 70x108 ins., but the firebox surface has been increased 583 sq. ft., making approximately 768 sq. ft. of firebox surface. This surface is so considerable, and it is so arranged, as to cause perfect and direct cycles of circulation of water upward through the tubes and about the firebox in general, which will cause rapid heat absorption, prevent scale formation, make expansion and contraction uniform and stimulate evaporation and cause liberation of steam, making it possible to reduce combustion to approximately one-half the present rate. That the circulation about the firebox may have additional freedom, a sheet is placed 30 ins. forward of the back tube sheet; the top of this is below the upper flues and serves as a dam to keep the cold inlet water forward and away from the firebox until it has been warmed to 300 or 312 degrees, when it overflows the dam and meets the circulating currents about the firebox. The necessary flue holes in this dam are not a tight fit to the flues.

It is believed that boilers constructed along these lines can be depended upon for reliability and economical maintenance, and that, as the water tubes protect the sheets, there should be freedom from cracked sheets, leaking flues, leaky seams and broken and leaky staybolts. There should be "continuous development of maximum horse power within the capacity and endurance of the average fireman," and we should have an "efficiency approaching as closely as possible to that of the best stationary boilers."

When we consider that from 40 to 45 per cent. of the total quantity of the steam produced is generated by the firebox, it must be apparent that reliability and low cost of maintenance must depend mainly upon freedom of circulation about the firebox, and it follows that a square foot of direct or firebox surface must have a value far in excess of the flue surface, and, in fact, it has approximately seven times the value. From experiment the average evaporation per square foot of firebox surface is 28.3 lbs. and the maximum evaporation of the flue surface is 4.7 lbs. per sq. ft. The reason for this is probably due to the gases becoming divided and reduced in temperature to such an extent, in their passage through the flues, that the combustion ceases in the flues, while in the firebox there is continuous combustion.

Therefore, an increase in direct or firebox surface of 583 sq. ft. would, theoretically, be the equivalent of approximately 4,081 sq. ft. of the average flue surface. If this can be sustained in practice remains to be controverted. There is no doubt, however, that the greatest effect due to the heat given off by the combustion of fuel is in the region of the firebox. Therefore, to increase the boiler horse power, stimulate evaporation by an increased circulation of water where the heat is most intense.

The following tables show the principal dimensions of the Pacific type locomotive mentioned above, which is now in service, and also what the dimensions would be as equipped with a water tube boiler:

	Fire Tube.	Water Tube.
Grate area	54 sq. ft.	51 sq. ft.
Heating surface of flues	3,700 sq. ft.	4,064 sq. ft.
Heating surface of firebox sheets	185 sq. ft.	230 sq. ft.
Heating surface of water tubes		538 sq. ft.
Heating surface of total	3,885 sp. ft.	4,832 sq. ft.
Length of flues	20 ft.	20 ft.
Number of flues	314	345
Diameter of flues (O. D.)	2¼ ins.	2¼ ins.
Average length of water tubes		5 ft. 5 ins.
Number of water tubes		152
Diameter of water tubes (O. D.)		2½ ins.
Water tubes secured by		Expansion
Ratio of heating surface to grate surface	72	95
Percentage of firebox surface to total	4.7	15.9
Weight of engine, total	219,690 lbs.	225,000 lbs.
Weight on drivers	143,190 lbs.	145,000 lbs.
Weight on trailing truck	38,800 lbs.	42,000 lbs.
Weight on leading truck	37,700 lbs.	38,000 lbs.
Firebox	73x109 ins.	70x108 ins.
Flue centres	3 ins.	3 ins.
Driving journals, main	10x12 ins.	10x12 ins.
Driving journals, F. & B.	9x12 ins.	9x12 ins.
Trailing truck journals	8x12 ins.	8x12 ins.
Tender truck journals	5½x10 ins.	5½x10 ins.
Valve travel	5½ ins.	5½ ins.

THE DRAFTSMAN'S FUTURE.

To the Editor:

My subscription to your Journal expires, I believe, on April 1st of this year. I have been a subscriber for a number of years and have found your paper very helpful and it is with reluctance that I have to ask you to drop me from your subscription list.

I entered railroad work about seven years ago as a machinist apprentice and rose to the position of draftsman in less than two years, the remainder of my four years apprenticeship was spent at the board. Consequently, your articles on the future of the draftsman were quite interesting to me, especially so as they came about the time that I began to realize that the drafting room was a corner in which a young man would soon be lost sight of and forgotten, although he might make a hard struggle to get out in the race again. I fought my battles, but with no success, except promises of what the future would bring. Three years ago I had an offer to enter the telephone field of which I had absolutely no knowledge, and as I had become disheartened by the treatment I received from the railroad, I accepted this offer and to-day my salary is double that which I received from the railroad company when I left them, which makes it equal to that of the leading master mechanic of any of our trunk lines. Since leaving the railroad I have received requests from railroad people to send them draftsmen, but have been unable to supply the demand. I note in the last issue of your Journal that you state that your list of draftsmen is also exhausted. It seems to me that it is about time the railroad companies of this country were awakening to the fact that if they expect to keep draftsmen, they must make positions in the drafting room in the line of promotion to such positions as master mechanic. In this way they would be able to draw from the shop bright young men, who do not care to take up this work, as they believe that if they do so they will enter the side track and the dispatcher will fail to give them the necessary orders, which will give them the right to the main track to enable them to reach the home terminal. This subject has been a pretty well hashed over in your columns, but I fear there are still a great many railroad officials who do not see the matter in the proper light. None of the above is intended as an adverse criticism of the officials with whom I came in contact. I think the trouble was higher up.

X. Y. Z.

I firmly believe that the really great savings to be made in our shops are the small savings when added together, the savings on the small items.—*Mr. A. E. Manchester, Western Railway Club.*

50-TON STEEL GENERAL SERVICE DROP BOTTOM GONDOLA CAR.

DROP BOTTOM GENERAL SERVICE STEEL GONDOLA CAR.

The Frisco System is receiving 200 all-steel 100,000-lb. capacity drop-bottom general-service gondola cars, half of which are for the Chicago & Eastern Illinois Railroad and half for the Kansas City, Fort Scott & Memphis Railroad. When the drop-doors are closed the floor of the car is flat, and to all appearances it is an ordinary flat-bottom gondola car without hoppers. When the doors are open the car will discharge 99 per cent. or more of the load without shoveling; they may therefore be used for coal or gravel and all kinds of material that will require dumping, or, because of the flat surfaces, they may be used equally well for material which is to be shoveled out where dumping is not feasible, or they may be used for the loading of lumber, pipe, bar iron, brick, sewer pipe or any material which cannot conveniently be loaded in hopper cars.

GONDOLA CAR AFTER DUMPING.

On March 7th a test of one of these cars was made at the works of the National Tube Company, McKeesport, Pa., to demonstrate the rapidity with which the car could clear itself in dumping. The car was loaded with 99.300 lbs. of run of mine coal, which was somewhat less than the capacity of the car level full. One of the illustrations shows the car on a trestle in the process of dumping part of the load. The other view shows an interior view of the car after dumping. One end of the car over the truck retained more of the load than the other end, probably because the end was on a curve and the elevation decreased the angle of inclination of the two doors immediately over the truck. It was estimated that not over 600 or 700 lbs. of coal remained in the car, or less than .7 of 1 per cent. of the total load. The greater part of this would probably have been displaced if the car had been jarred by the coupling on of an engine. The time required for dumping was about 6 seconds for each half of the car, and the time consumed in closing the doors was about one-half a minute for each of the four sections. The car could be placed, dumped and the doors closed to form a flat-bottom gondola car by two workmen in 4 minutes or less.

One of the illustrations shows the interior of one of the cars with the doors closed.

Practically the entire floor of the car is made up of drop-doors, 16 in all. The 8 doors over the trucks drop to a clear opening of 23 ins. and the 8 in the centre of the car have a clear opening of 26 ins. The centre sills are compressed to form an inverted V and are riveted to a T-shape, the flange of which forms the centre ridge of the car and is only 4 ins. wide. The sills are reinforced with angles at the lower edges. The body bolsters are built up of plates and angles and are 7 ins. wide. The cross-bearers are of pressed steel shapes and present a 3-in. top surface. The doors are operated by what is known as a "creeping shaft" mechanism, which is carried in slats by the cross-bearers and bolsters, and while the doors are closed, by chains attached to the shafts; the latter are automatically moved underneath the doors when they are fully closed, and the load is thus securely supported and accidental discharge is impossible.

The general dimensions of these cars, which were designed and constructed by the Pressed Steel Car Company, are as follows:

Length over end sills	42 ft. 9 ins.
Length inside of body	41 ft. 9 ins.
Width over stakes	10 ft. 2 ins.
Width inside	9 ft. 6¾ ins.
Depth of body to top of sides	4 ft. 4 ins.
Length of doors in clear	4 ft. 10 ins.
Width of doors in clear	4 ft. 2½ ins.

STANDARD ATLANTIC TYPE LOCOMOTIVE—HARRIMAN LINES.

Height of floor from top of rail....................4 ft. 5 ins.
Truck centres....................................31 ft. 0 ins.

STANDARD ATLANTIC TYPE LOCOMOTIVE.

HARRIMAN LINES.

In the March number of this journal we illustrated a Pacific type locomotive, which was constructed on the standard design adopted by the Harriman Lines last year, which were completely illustrated in the AMERICAN ENGINEER, 1905, pages 154, 200, 250, 288, 320, 353, 400 and 441.

The illustration herewith shows the corresponding Atlantic type, an order of which has recently been constructed by the Baldwin Locomotive Works for the Southern Pacific Company. Locomotives of similar type, but equipped for burning coal, have also been built for the Union Pacific system and the Chicago & Alton.

GONDOLA CAR WITH DROP DOORS CLOSED.

The engine here shown is an oil burner and has 20x28-in. cylinders, 81-in. drivers and 200 lbs. steam pressure. The weight on driving wheels of 105,000 lbs. bears a ratio of 4.46 to the tractive effort, which is 23,500 lbs.

The boiler has a straight top and the tubes are spaced with ⅞-in. bridges. The mud ring is 5 ins. wide on all sides. The firebox is provided with a shallow ash pan and the oil burner is placed in the front end of the box.

The cylinders are fitted with a modification of the Sheedy circulating valve, the seat for which is located in the cylinder casting. The piston valves are 12 ins. in diameter and are driven by indirect link motion.

The frame has double front rails and has the main and trailing section in one piece. The trailing rigging is rigid and gives a rigid wheel base of 15 ft. 9 ins. to these engines, the driving wheel base being but 7 ft.

An unusually large tank has been applied, which is arranged with a water bottom and carries 9,000 gallons of water. The oil supply is carried in a separate tank located in the fuel space, and has a capacity of 2,835 gallons of oil.

The general dimensions, weights, ratios and side elevation of these engines will be found in the AMERICAN ENGINEER, 1905, pages 154 and 155.

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50-TON STEEL GENERAL SERVICE DROP BOTTOM GONDOLA CAR.

DROP BOTTOM GENERAL SERVICE STEEL GONDOLA CAR.

The Frisco System is receiving 200 all-steel 100,000-lb. capacity drop-bottom general-service gondola cars, half of which are for the Chicago & Eastern Illinois Railroad and half for the Kansas City, Fort Scott & Memphis Railroad. When the drop-doors are closed the floor of the car is flat, and to all appearances it is an ordinary flat-bottom gondola car without hoppers. When the doors are open the car will discharge 99 per cent. or more of the load without shoveling; they may therefore be used for coal or gravel and all kinds of material that will require dumping, or, because of the flat surfaces, they may be used equally well for material which is to be shoveled out where dumping is not feasible, or they may be used for the loading of lumber, pipe, bar iron, brick, sewer pipe or any material which cannot conveniently be loaded in hopper cars.

GONDOLA CAR AFTER DUMPING.

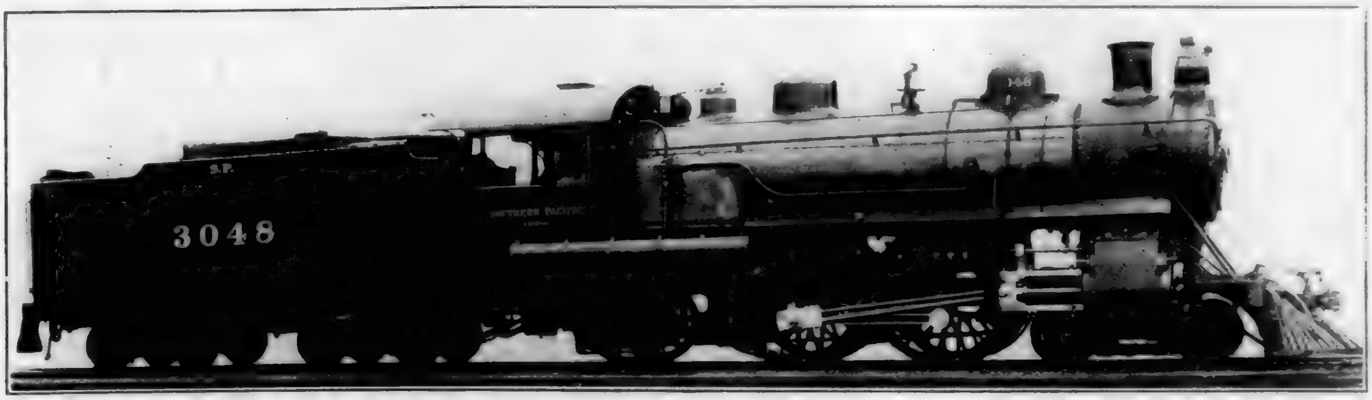
On March 7th a test of one of these cars was made at the works of the National Tube Company, McKeesport, Pa., to demonstrate the rapidity with which the car could clear itself in dumping. The car was loaded with 99.300 lbs. of run of mine coal, which was somewhat less than the capacity of the car level full. One of the illustrations shows the car on a trestle in the process of dumping part of the load. The other view shows an interior view of the car after dumping. One end of the car over the truck retained more of the load than the other end, probably because the end was on a curve and the elevation decreased the angle of inclination of the two doors immediately over the truck. It was estimated that not over 600 or 700 lbs. of coal remained in the car, or less than .7 of 1 per cent. of the total load. The greater part of this would probably have been displaced if the car had been jarred by the coupling on of an engine. The time required for dumping was about 6 seconds for each half of the car, and the time consumed in closing the doors was about one-half a minute for each of the four sections. The car could be placed, dumped and the doors closed to form a flat-bottom gondola car by two workmen in 4 minutes or less.

One of the illustrations shows the interior of one of the cars with the doors closed.

Practically the entire floor of the car is made up of drop-doors, 16 in all. The 8 doors over the trucks drop to a clear opening of 23 ins. and the 8 in the centre of the car have a clear opening of 26 ins. The centre sills are compressed to form an inverted V and are riveted to a T-shape, the flange of which forms the centre ridge of the car and is only 4 ins. wide. The sills are reinforced with angles at the lower edges. The body bolsters are built up of plates and angles and are 7 ins. wide. The cross-bearers are of pressed steel shapes and present a 3-in. top surface. The doors are operated by what is known as a "creeping shaft" mechanism, which is carried in slats by the cross-bearers and bolsters, and while the doors are closed, by chains attached to the shafts; the latter are automatically moved underneath the doors when they are fully closed, and the load is thus securely supported and accidental discharge is impossible.

The general dimensions of these cars, which were designed and constructed by the Pressed Steel Car Company, are as follows:

Length over end sills	42 ft. 9 ins.
Length inside of body	41 ft. 9 ins.
Width over stakes	10 ft. 2 ins.
Width inside	9 ft. 6¾ ins.
Depth of body to top of sides	4 ft. 4 ins.
Length of doors in clear	4 ft. 10 ins.
Width of doors in clear	4 ft. 2½ ins.



STANDARD ATLANTIC TYPE LOCOMOTIVE—HARRIMAN LINES.

Height of floor from top of rail....................4 ft. 5 ins.
Truck centres.....................................31 ft. 0 ins.

STANDARD ATLANTIC TYPE LOCOMOTIVE.

HARRIMAN LINES.

In the March number of this journal we illustrated a Pacific type locomotive, which was constructed on the standard design adopted by the Harriman Lines last year, which were completely illustrated in the AMERICAN ENGINEER, 1905, pages 154, 200, 250, 288, 320, 353, 400 and 441.

The illustration herewith shows the corresponding Atlantic type, an order of which has recently been constructed by the Baldwin Locomotive Works for the Southern Pacific Company. Locomotives of similar type, but equipped for burning coal, have also been built for the Union Pacific system and the Chicago & Alton.

GONDOLA CAR WITH DROP DOORS CLOSED.

The engine here shown is an oil burner and has 20x28-in. cylinders, 81-in. drivers and 200 lbs. steam pressure. The weight on driving wheels of 105,000 lbs. bears a ratio of 4.46 to the tractive effort, which is 23,500 lbs.

The boiler has a straight top and the tubes are spaced with ⅞-in. bridges. The mud ring is 5 ins. wide on all sides. The firebox is provided with a shallow ash pan and the oil burner is placed in the front end of the box.

The cylinders are fitted with a modification of the Sheedy circulating valve, the seat for which is located in the cylinder casting. The piston valves are 12 ins. in diameter and are driven by indirect link motion.

The frame has double front rails and has the main and trailing section in one piece. The trailing rigging is rigid and gives a rigid wheel base of 15 ft. 9 ins. to these engines, the driving wheel base being but 7 ft.

An unusually large tank has been applied, which is arranged with a water bottom and carries 9,000 gallons of water. The oil supply is carried in a separate tank located in the fuel space, and has a capacity of 2,835 gallons of oil.

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(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL

PUBLISHED MONTHLY

BY

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Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT,
E. A. AVERILL, } Editors.

APRIL, 1906.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*
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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase of construction.*

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Mr. Jacob's address to college students, which is partially reproduced on another page, should be read by all those who are interested in the matter of shop production. It is not surprising that the engineering colleges have neglected to impress the students with the importance of the cost of production. It is only during the past few years that the manufacturing concerns have waked up to the importance of this problem, and apparently some of the railroad shop managements are still blissfully unaware of it. The successful shop manager is one who realizes the importance of studying the cost of production with a view to reducing it and increasing the shop output.

While walking through a large railroad shop where piece work is in force the power was shut off for a few minutes, due to a slight accident in the engine-room. The difference between a piece-work and a day-work shop was immediately apparent. The men, instead of lounging about or gathering in groups, started to oil up or adjust their machines and to arrange such work as might be lying on the floor, so that it could be handled with a minimum loss of time. The shop superintendent remarked that if anything interfered with the progress of the work, such as poorly or badly designed material, lack of material, poor light or inefficient tools, the men lost no time in notifying him. His time was not taken up by looking for weak spots, but rather to remedying the defects after they had been located.

It is comparatively easy to make a reputation in building very large locomotives. It is equally important, if more difficult, to make a reputation for the improvement of relatively light locomotives, which constitute the major part of the equipment of most railroads. It is in this direction that the superheater appears to offer at the present time its greatest advantage. Because it increases the capacity of the locomotive by improving its use of steam and because of its applicability to existing locomotives, the superheater appears opportunely, and if the good results now promised are obtained, the application to old locomotives is undoubtedly an advantage for this device. Thus far, superheating has proved a remarkable innovation, in that no serious or insurmountable difficulties have appeared. One feature of superheating, which is specially interesting in its application to old locomotives, has not yet received the attention which it merits. That is the possibility of reducing steam pressure without loss of power. This will lead to a great relief in boiler work.

During the year 1905 there appeared in this journal a very complete description of the standard locomotives to be used on the Harriman Lines. It will be remembered that the committee in that case released themselves from all bonds and adopted designs for all parts, which, after careful study, were decided to be the best possible design to be obtained at that time. These were to be used on all new power built after their adoption, and their application to the older engines already in use was a secondary consideration. In this issue appears the first part of an article descriptive of the standards recently adopted by the Canadian Pacific Railway for locomotive parts. In this case, while the designs are for use on all new power, and are up to date in every particular, primary attention has been given to their application to the locomotives already in service which are of comparatively recent design and will be in operation for many years to come. An examination of the table given will show that most gratifying results have been obtained; also that the standards have been carried much further than has heretofore been attempted, as, for example, the motion work and cylinders.

Often a man who is selected as a foreman is picked out because of his exceptional qualities as a skilled workman, but he may be for this very reason unsuccessful. A skilled workman does not necessarily make a poor foreman, but neither does he necessarily make a good one. Probably the chances are in favor of one who is not exceptional as to workmanship. While this quality is desirable, it is not so much needed in foremanship as the ability to take a birdseye view of the work of others. A man is needed who can plan and execute, who can keep the continuity of the work in his mind and bring various factors together to fit accurately, both as to mechanical construction and as to time. He must be a manager, able to keep material supplied and to see that work upon which other work depends is done in its proper time. Of course, management of men is important, but there is danger of over-management. Men want to be treated as men, and neither nagged nor coddled, but helped by every proper means so that their work will go smoothly and fit in with that of others. None are so quick as the workman to see whether or not there is any lost motion in their efforts, and none are quicker to see whether or not their efforts contribute directly to a smooth working plan which brings results by the shortest path. A perfect mechanic is more likely to watch only one part and to forget the necessity for management. Perhaps a laborer will be the better material than the skilled mechanic, but, of course, there are many steps between these positions. To make the selection, a thorough knowledge of every man is necessary, and in a large plant this is of course difficult. With the increase in size of an organization, it is becoming increasingly difficult to know the men individually, and at the same time it is becoming more and more necessary that some one should know them. The best preparation for selecting a foreman is a thorough knowledge of all the men, their capabilities and their possibilities.

One of the reports presented to the Master Mechanics' Association last year, which merits special attention, is that of the committee on time service of locomotives. This was printed in our August number, page 312. In this report a careful record of the service of a freight locomotive for a month, showed that the total time the locomotive was in the

hands of the motive power department was 22.6 per cent., the total time in the hands of the transportation department 46.8 per cent., and the proportion of the time when actually running was 28.7 per cent. These figures should not be used in comparing the departments and their relative responsibilities in the matter of the operation of locomotives, so much as to show the very great importance of the intimate association of the two departments and the necessity for the personal co-operation of the officers of both in the interest of the road as a whole. Undoubtedly, there is a great deal of dodging of responsibility in the matter of locomotive service. Cases are on record showing that transportation officers are not always careful to help the motive power men as much as possible in the ordering of locomotives for trains. Locomotives are too often ordered long before they are wanted, and the motive power department is continually traveling up-hill in order to meet requirements. There is no closer point of contact between the transportation and the motive power department than in the matter of locomotive service, and herein lies an opportunity for a development of good feeling and cordial co-operation, which does not appear as often as it should. One way to help matters along is to adopt a combination record blank for the roundhouse and the yard, showing all movements of the engines and giving the time of each, including the time locomotives are ordered for trains. Such information blanks have been adopted by several roads with very great advantage, and they have shown conclusively that locomotive movements at terminals can be greatly accelerated by the co-operation of the departments, exerted with a view of mutual helpfulness in every case.

MALLET COMPOUNDS FOR ROAD SERVICE.

For very large locomotive units required for handling heavy trains over steep grades which necessitate a pushing service, the advantages of the Mallet articulated type appear to be obvious in the experience of the Baltimore & Ohio Railroad with a locomotive of this type, which was described in this journal in June, 1904, page 237. That the Mallet articulated compound possesses perhaps equal advantages for heavy road service is not so generally understood, yet this seems to be the fact, for the following reasons:

With a Mallet articulated compound about 50 per cent. more load can be hauled than can be handled by the usual type of simple locomotive with its weight on four driving axles, allowing the same weight per axle. About 50 per cent. additional load can be hauled by a Mallet compound in heavy work without increasing the fuel consumption beyond the amount required by the simple locomotive. Stated on a ton mile basis, this amounts to a saving of about one-third in fuel. To accomplish this result only one crew is necessary.

Aside from the higher total tractive power of the Mallet compound, a higher tractive power related to the weight per axle can be obtained because of the conditions under which the two engines of the Mallet compound operate. This is because, in starting, the high cylinder pressures which cause slipping do not occur at the same time in the high and low pressure engines. If one engine slips, it reduces its own working pressure and takes its grip on the rail again automatically without the necessity of throttling. While the first engine slips the second engine gains in power and prevents a cessation of the drawbar pull, which may, in an ordinary engine, cause the stalling of the train if it occurs at a critical time. One notable feature in the operation of the Baltimore & Ohio Mallet compound is that in starting the train the drawbar pull is partially maintained in case either engine slips.

In this type of locomotive the entire weight is utilized for tractive purposes, and complications of trucks are avoided. This saving of complication is partially balanced by increasing the number of working parts, but in so doing a material gain in efficiency is secured.

In a very powerful locomotive, requiring eight or more driving wheels, the curve resistance is an item of moment. The Mallet compound offers a shorter, rigid wheel base, and must necessarily be less severe in its effect upon the track and must consequently lose less power in moving itself. With the compound applied according to this principle, a reserve starting capacity is available by the use of direct steam in all four cylinders, which means an advantage of about 20 per cent. of the normal power of the locomotive. In starting heavy loads and working on critical grades this feature of the compound locomotive is exceedingly valuable.

The Mallet compound has been criticized because of its complication. As a machine, it is undoubtedly complicated, but the division of the work of the enormous locomotive into two separate engines is unquestionably a step in the right direction, having in view the fact that main rods, crank pins and other working parts must be excessively large when made to withstand the stresses necessarily imposed upon them in very large locomotives of ordinary type.

The Mallet compound type therefore merits thoughtful consideration for general road service which requires locomotives of say 200,000 to 250,000 pounds total weight.

THE RAILROAD MECHANICAL ENGINEER.

A correspondent who has just taken a position as mechanical engineer on a good sized railroad, recently consulted the editor of this journal as to the duties of such a position. This gave the editor a chance to air his views for the benefit of the young man, and thinking that they may also be suggestive to others the reply to the correspondent's letter is herewith presented.

The mechanical engineer should have a strong grasp of the power problem, knowing exactly what the locomotives are doing and should be prepared to say what locomotives should be purchased when the next opportunity presents itself for increasing the power. He should keep an exceedingly close watch of engine failures, and by aid of his drafting room study the details and improve them so that they do not break down. He should keep close watch of locomotive statistics, knowing which locomotives cost the most to repair per ton mile, and he can give exceedingly valuable assistance to the operating officials in connection with tonnage rating of locomotives, in order to get the proper work out of them. By a careful study of the roundhouse problem on his road he should be prepared to suggest ways in which a little money may be spent in such a manner as to help the operating department out of many of its difficulties, particularly in severe winter weather. There are many things which he should do in connection with the operation of locomotives, studying the grates, fireboxes, front ends and the adjustment of the engines so that they will steam freely, thus giving valuable assistance to the motive power and other departments. A mechanical engineer generally confines his attention to the theoretical parts of the work and spends a great deal of his time in the drafting room, which is all right as far as it goes. Such an official should make such a study of the conditions as to enable him to get more out of the locomotive, and thus assist the motive power department to more freely meet the problem of the operating department. To do this it is necessary to understand the roundhouse, the shop, the handling of locomotives on the road, the fuel and its use and many other things. The whole matter of mechanical engineer's duties might be summed up by saying that such an official ought to be, in fact, if not in name, assistant superintendent of motive power, drawing to himself many lines which now diverge and are lost because of the lack of attention, which is due to the great pressure of details crowding upon the superintendent of motive power.

The post of mechanical engineer of a large railroad constitutes one of the rarest opportunities available to men who are mechanically inclined. The post is not always appreciated. The position is not what it should be, but it shares with many other positions in affording an opportunity for hard, conscientious work to be very effective in making a

reputation, acquiring acquaintance, and establishing a position which is really indispensible. The position is often a discouraging one because it does not usually involve the management of large numbers of men, and a mechanical engineer is usually quite a little out of touch with the most vexing and most weighty questions which require the instant, unerring decisions which make men great. That the mechanical engineer is in a position to advance to take the other highest responsibilities both in administration and in organization does not seem to be appreciated. This post offers the very best opportunities for preparation for the highest responsibilities of the motive power department and that more mechanical engineers are not advanced to become heads of the departments is too often the fault of the mechanical engineers themselves.

It may be difficult for the mechanical engineer to see how he can make an impression upon his superiors. Each case presents its own problems, but in general it may be said that the mechanical engineer may in the long run make a very deep impression on the net earnings of the road, if he will give his attention to the power question and bring up his young assistants to look after the details. As to the possibility of showing executive ability and the instinct of management perhaps the mechanical engineer's position is not fully understood. In the matter of drafting-room work costs and results may be kept as carefully and as effectively as in the shops.

One large road, not by any mean the largest in the country, issued 15,000 blue prints last year, requiring about 8,000 yards of blue print paper, their cost being perhaps $900. This, however, is insignificant as compared with the hours of labor in that drawing-room, which amounted to about 45,000, which made the cost of each drawing, averaged between the large and the small, about $20. The mechanical engineer here deals with a labor problem involving costs which are by no means insignificant, and when each drawing costs $20 he should, for his own protection, see that every drawing fulfils its mission and tends toward a reduction of the total cost of the operation of the road.

Investigations of some of the very largest drafting-rooms in the country show that the draftsman who commands $125 per month turns out drawings at about one-third less per drawing than the poor draftsman who can command only $60 or $70 per month. The mechanical engineer by keeping close watch on his department should be able to make an impression upon his superiors with such an argument as this, and thus be able to strengthen himself with men of real value who will help him to place the mechanical engineer's office in a dominating position, because of its effectiveness in strengthening the motive power organization. The railroads by neglecting to make draftsmen are committing an error which amounts to a sin. Every railroad, and, in fact, every engineering establishment has, after all, the sort of draftsmen which it deserves.

The answer to this question requires pages and pages to properly cover the ground, but the whole matter may be summed up by remarking that the mechanical engineer may become the center from which pretty nearly everything in the way of improvements eminates. In these days of improvements of shops, shop equipment and shop methods a wonderful opportunity lies before the mechanical engineer. In these days of improvements, previously unheard of, in the locomotive itself an equally wide field is presented. The fact that the mechanical engineer is not to-day a dominating influence in railroad progress indicates that some one has failed to see the opportunity which should be very apparent to every one.

These paragraphs are intended as an encouragement. It is feared that they have drifted into rather a severe criticism. Believing that these remarks are justified in the hope of ultimately encouraging the reader by showing him the opening which lies before him they are sent on their mission.

FORGING AT THE COLLINWOOD SHOPS.

Lake Shore & Michigan Southern Railway.

The special tools and fixtures which are necessary to make the large frame and Bradley hammers, forging and bulldozing machines in our modern railroad shops a source of profit are usually developed by the local management. This is due to the fact that the design of locomotive and car details, as well as the shop equipment and conditions, varies greatly on different roads. The efficiency of the smith shop depends largely on the proper use of these machines, or, to be more specific, on the success which the foreman and his assistants may have in devising special tools and dies for making the different parts, many of which are of intricate design.

This subject has been very closely followed up at the Collinwood shops of the Lake Shore & Michigan Southern Railway, and a special tool department has been organized for the manufacture of dies for special forgings made in bolt headers, forging machines and bulldozers. This department is located near the forging machines, so that the blacksmith shop foreman can keep in close touch with the development of the tools and confer with the die maker without leaving his immediate territory. The result has been very satisfactory, and we are fortunate in being able to present photographs of some of the articles which are being made in this shop. Except where otherwise mentioned, these parts are made on a 3½-in. Ajax forging machine. The credit for the very successful results which have been gained is largely due to the efforts of the blacksmith foreman and his assistant. The number of forgings which can be turned out in a given time, in most cases, depends entirely upon the heating facilities. Most of the forgings are finished by two or three strokes of the machine, and the output where furnaces of sufficient capacity are provided is remarkable.

No. 1 is a truss rod anchor—a very difficult forging to make, owing to the peculiar construction of the socket for the rod, the jaws being tied together by a web extending well forward. This forging is made complete in two operations from 1½ by 3½-in. commercial bar iron, the first operation forming the jaw complete, and the second forming the offset and shoulder. No. 2 is the end of a shaft crank. Two operations are required; the boss is formed in the first and the square hole is punched and finished in the second. No. 3 shows a plain upset easily formed in one operation. It is made in large quantities, and, while simple, would consume considerable time under the hammer. No. 4 is a hinge, each part of which is formed in one operation.

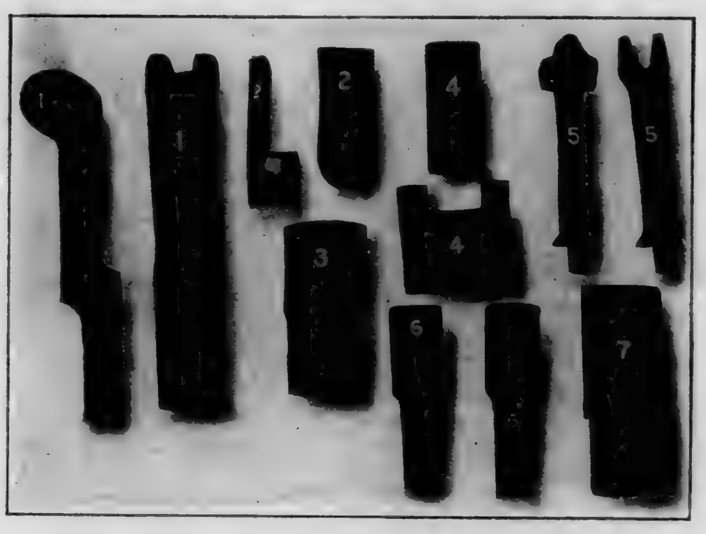
No. 5 is a truss rod column post. The receptacle for the truss rod is first formed, the rod is then pinched to form the pin, and the collar is formed in the third or last operation. No. 6, a grate shaker bar, is a specially difficult forging to make. As will be noted, the wrench is shown in full on the left and in section on the right. A band of iron, similar to a spring band, is first formed in special dies under a Bradley hammer. This part is then placed loosely on the bar, is heated in an oil furnace and welded and formed in one operation in the forging machine. No. 7 shows a simple upset and flange. Nos. 8 and 11 show two views of a toggle for a mail car which is made in two operations. This piece is punched from stock in the forging machine, and is then bossed and finished in a suitable die under a steam hammer. This forging could be made complete in a 5-in. Ajax forging machine.

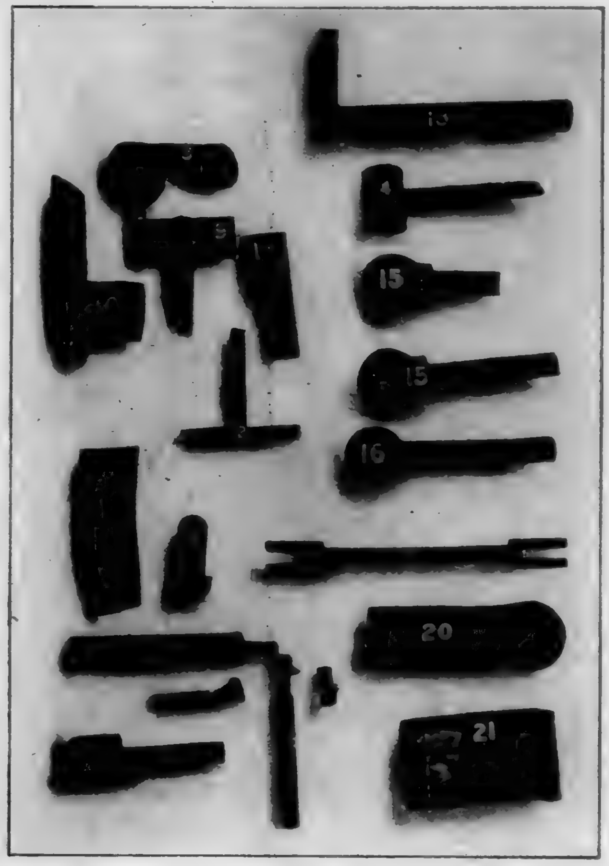
Nos. 9, 10 and 12 are carline ends for baggage, mail and caboose cars which may be cheaply formed in the forging machine. Nos. 9 and 12 are formed by bending a piece of flat stock in the shape of a U. This is placed loosely on the end of the bar, heated to a welding heat, and the foot is formed in one operation. With No. 10 a square hole is punched in the stock and the foot is sheared from the bar to leave a square end. This square pin is placed in the hole, both pieces are heated to a welding heat and the foot is formed in one operation. Nos. 13 to 19 are simple operations, with the ex-

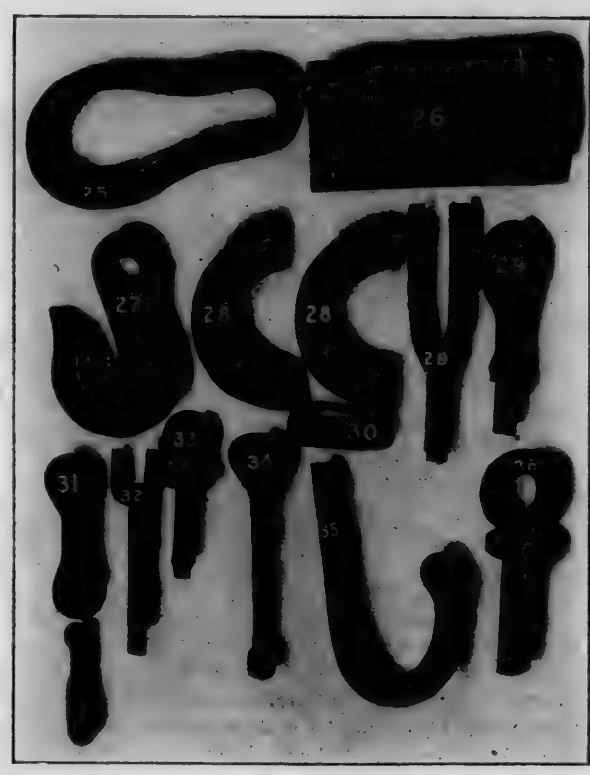
ception of No. 14, which might be puzzling to one not thoroughly acquainted with this class of work. It is formed in one operation from ½ by 2-in. flat stock with a boss 2 ins. in diameter and 3 ins. long.

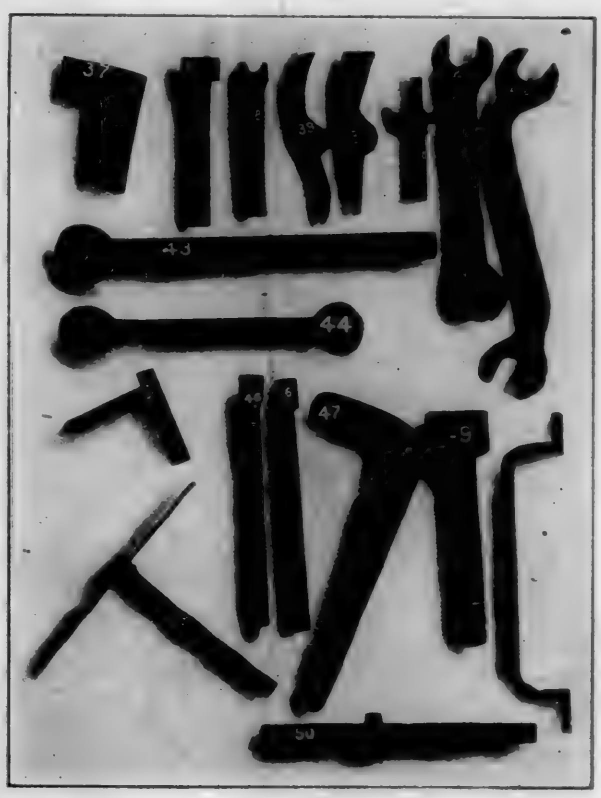
No. 20 shows the end of a spring hanger for heavy freight and passenger engines. The bar is cut to the proper length, both ends are upset, and it is then bent to the proper shape on a bulldozer. No. 21, the end of a coupler pocket, is punched, flanged, and the flange sheared to length in one stroke of the forging machine. The only objection to this is a slight stretching of the metal around the first hole, but this is being corrected by changing the dies to compress the flange. No. 22, a patch bolt, is formed and nicked on the end of the bar in one operation. Nos. 23 and 24 are also made in one operation.

No. 25, a link for a wrecking chain, is first bent to shape on a bulldozer, so that the ends overlap on the small end. These are then sheared to form a scarf, and are welded in special dies under a Bradley hammer, the entire link being completed in three operations. No. 26, a double follower plate with solid bosses, is formed in one operation on a bulldozer. The bosses are formed by two ball-faced punches forcing the metal into large dies and leaving the walls of sufficient thickness for the required strength. This form is cheap and much more satisfactory than where the lugs are riveted to the plate. No. 27, a hook for wrecking chains, is punched, formed, straightened, the hole punched and countersunk in two operations. No. 28, a center plate bearing, is made from a rectangular plate in one operation. No. 29, a brake rod fork, is punched from scrap, usually old transoms, in a bulldozer. It is then welded and drawn out under a Bradley hammer.







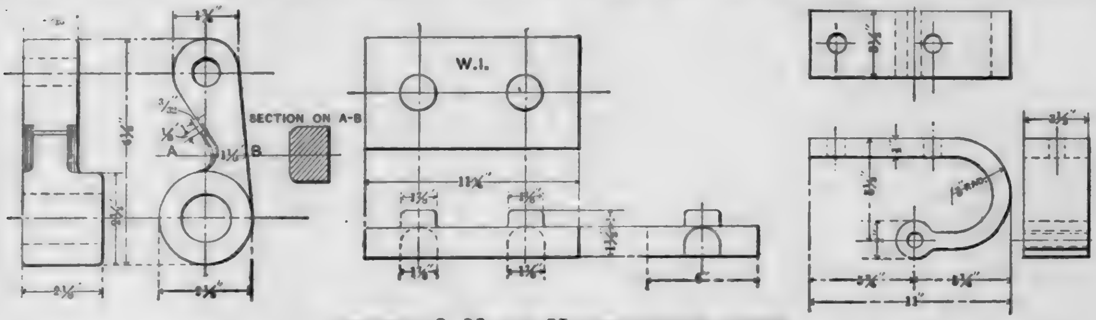


FORGINGS MADE AT THE COLLINWOOD SHOPS—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

No. 30, a split key, is bent and trimmed in a bulldozer in two operations. No. 31, a crown bar link, is punched from a flat bar in one operation. This design gives uniform strength and

maximum clearance. No. 32, a bell clapper fork, is made in two operations. Nos. 33, 34 and 36 are made under the hammer. No. 35 is a spring hanger, the boss being formed in one operation in the forging machine. It is then bent in a bulldozer. Nos. 37 and 38 are made in one operation each. No. 39, a ratchet and pawl, is made in two operations. It is first punched from steel stock in a forging machine and is then flattened, bent and cut to the proper angle under a Bradley hammer.

No. 40, a steel relief valve, is formed in the forging machine from round stock in two operations. Nos. 41 and 42



FORGINGS 8, 26 AND 35—COLLINWOOD SHOPS.

show the various steps in manufacturing a wrench. No. 42 represents a finished ¾ and ⅞-in. wrench for car repairers. After much careful study a set of dies were constructed for making one end of the wrench complete in a forging machine from 1-in. round steel in three operations. The center is then finished in special dies under a Bradley hammer. The wrench comes from the machine finished, requiring no dressing. No. 43, a standard wedge bolt, is made from 1¼-in. stock. No. 44 is a spring hanger, each end of which is formed in one operation.

No. 45 is a cheap and very satisfactory ash hoe. A 1⅛-in. oval hole is first punched in the plate. The rod is then heated, and one stroke of the machine forms a head on each side of the plate and also compresses the metal into the oval hole, preventing the bolt from turning in case the heads should loosen in service. No. 46, a socket wrench, is made in one operation. No. 47 is similar to No. 14. The boss is formed in one operation, and the shank is then bent and formed in one operation in a bulldozer. No. 48 is a grab handle. The foot is formed, punched, and the rod is bent with one heating and one handling for each end and straightened ready for application. No. 49 is made in one operation. No. 50, a collar wedge bolt, is formed and squared in two operations.

In addition to the above a number of cast iron formers are used in connection with the bulldozer for the cold and hot bending of arch bars, transoms, grate side bars, etc. A jib crane with a chain hoist serves to transfer the formers to and from the machine. We are indebted for photographs and information to Mr. M. D. Franey, superintendent of the Collinwood shops.

PACIFIC TYPE PASSENGER LOCOMOTIVE.

SOUTHERN RAILWAY.

The Baldwin Locomotive Works has recently delivered an order of 20 very powerful Pacific type locomotives to the South Railway. Fifteen of these engines have 63-in. drivers and the the remaining five 72½-in. drivers, otherwise the design being very similar. The illustrations herewith apply to the latter class.

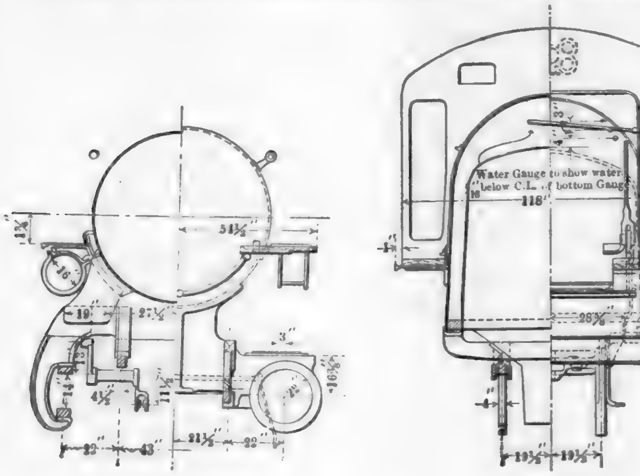
The cylinders, which are single expansion, are 22 ins. diameter by 28-in. stroke, which, taken in connection with the steam pressure of 220 lbs. and driving wheels of 72½ ins., gives a tractive effort of nearly 35,000 lbs. In this they are the most powerful engines of this type of which we have a record. The weight on drivers is 138,460 lbs., giving a factor of adhesion of 3.97. The ratio of total weight to tractive effort is 6.31, the weight on drivers being 62⅓ per cent. of the total weight.

The boiler is of the straight top type with sloping throat and back head. The firebox is radial stayed. The longitudinal seams in the boiler are butt jointed and are welded at each end. The flues, of which there are 314—2¼ ins. in diameter, are 20 ft. long and give a heating surface of 3,683.5 sq. ft. The boiler is liberally supplied with washout plugs and has ⅜-in. liners in the waist over the supporting guide bearers and waist sheets. The check valve is located somewhat further back from the front flue sheet than has been customary.

PACIFIC TYPE PASSENGER LOCOMOTIVE—SOUTHERN RAILWAY.

Slide valves are used and the rocker arm, which is placed forward of the front drivers, operates the valve stem through a cross-head connection. The frames are of cast-steel and have double front rails spanning the cylinders. The rear sections are separate from the main frames and connect with a splice at the front end of the firebox, which is supported at this point by a vertical plate. The trailer truck is of the Rushton type and is equalized with the drivers. The cab is placed somewhat further back than usual, giving a fair-sized deck.

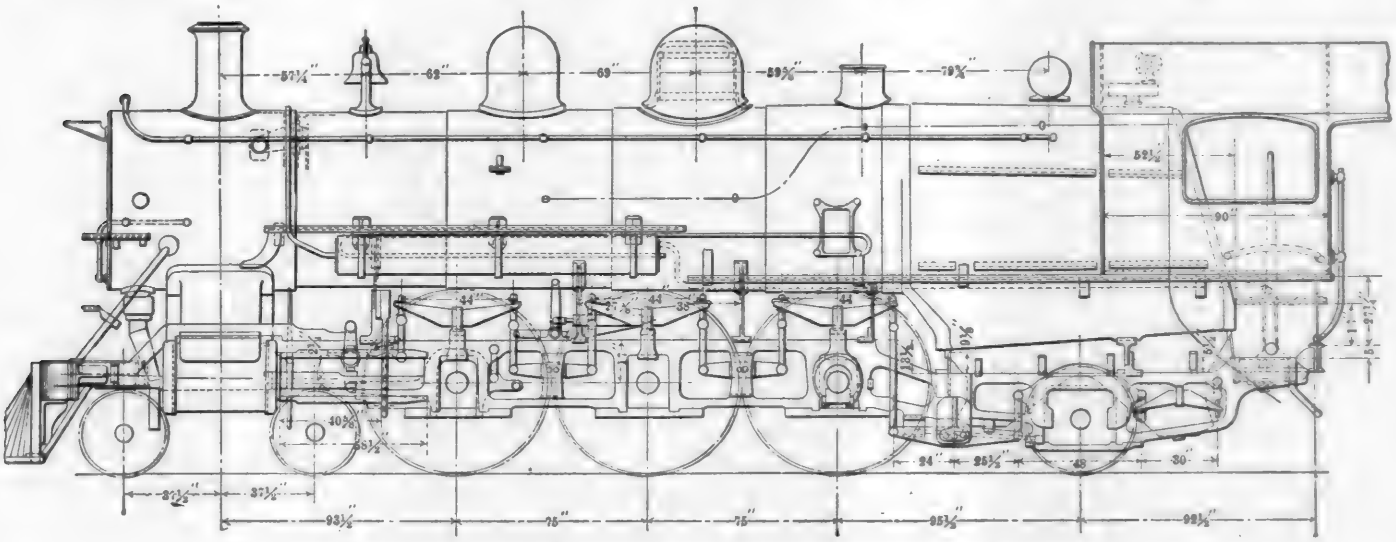
In the matter of details these engines present nothing particularly novel, employing such parts as long practice has proven to be satisfactory. The general dimensions, weights and



CONVENIENT TOOL BOX FOR ROUNDHOUSES.

This engraving illustrates a portable tool box which is used to very good advantage in the shops and roundhouses of the Lake Shore & Michigan Southern Railway at Elkhart, Ind. The box is built upon a two-wheel truck, the axle and wheels of which are placed in such a position that the box itself may stand upon end upon the floor, or it may be used in a horizontal position for the men to stand upon in working about the locomotives. The engraving requires no further description. Where they are used a great deal of blocking and horses or trestles are avoided in the shops. We are indebted to Mr. C. W. Cross, former master mechanic, for the drawing.

Largest Tonnage per Hour.—For slow freight service, where a greater tractive power is desired than what can be obtained from a properly designed Consolidation type locomotive, it



ELEVATION AND SECTION, PACIFIC TYPE LOCOMOTIVE—SOUTHERN RAILWAY.

ratios given below, together with the side elevation and general view shown herewith, will illustrate the principal features of these very powerful locomotives:

SIMPLE PACIFIC TYPE PASSENGER LOCOMOTIVE, SOUTHERN RY.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger.
Fuel	Bituminous coal.
Tractive Power	34,940 lbs.
Weight in working order	220,500 lbs.
Weight on drivers	138,460 lbs.
Weight on leading truck	39,700 lbs.
Weight on trailing truck	42,300 lbs.
Weight of engine and tender in working order	358,000 lbs.
Wheel base, driving	12 ft. 6 ins.
Wheel base, total	31 ft. 4½ ins.
Wheel base, engine and tender	64 ft. 5⅝ ins.
RATIOS.	
Tractive weight ÷ tractive effort	3.97
Tractive effort x diam. drivers ÷ heating surface	653
Heating surface ÷ grate area	71.5
Total weight ÷ tractive effort	6.31
CYLINDERS.	
Diameter and stroke	22 by 28 ins.
Valves	Balanced slide.
WHEELS.	
Driving, diameter over tires	72½ ins.
Driving, thickness of tires	3¼ ins.
Driving journals, main, diameter and length	10x12 ins.
Driving journals, others, diameter and length	9x12 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	5½x10 ins.
Trailing truck wheels, diameter	42 ins.
Trailing truck, journals	8x12 ins.
BOILER.	
Style	Straight.
Working pressure	220 lbs.
Outside diameter of first ring	70 ins.
Firebox, length and width	108⅛x72¼ ins.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	4½ and 3½ ins.
Tubes, number and outside diameter	314-2¼ ins.
Tubes, gauge and length	20 ft.
Heating surface, tubes	3,683.5 sq. ft.
Heating surface, firebox	195 sq. ft.
Heating surface, total	3,878.5 sq. ft.
Grate area	54.25 sq. ft.
TENDER.	
Wheels, diameter	33 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	7,500 gals.
Coal capacity	12½ tons.

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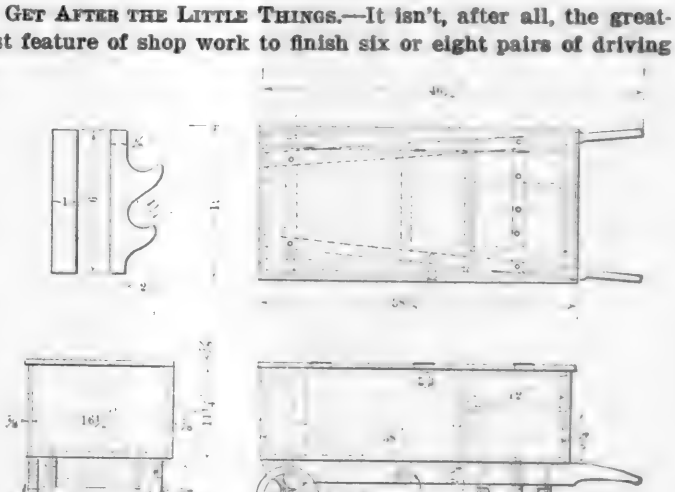

PORTABLE TOOL BOX FOR ROUNDHOUSES.

wheels per day, but it is a money-making scheme to put the closest thought on the 200 or 300 other jobs which keep 25 other machines busy and which, because they are small, we pass by regularly as being unimportant. More money can be made for your company by following up the 100 small items than by putting the major thought on the ten large items.—*Mr. C. J. Crowley, Western Railway Club.*

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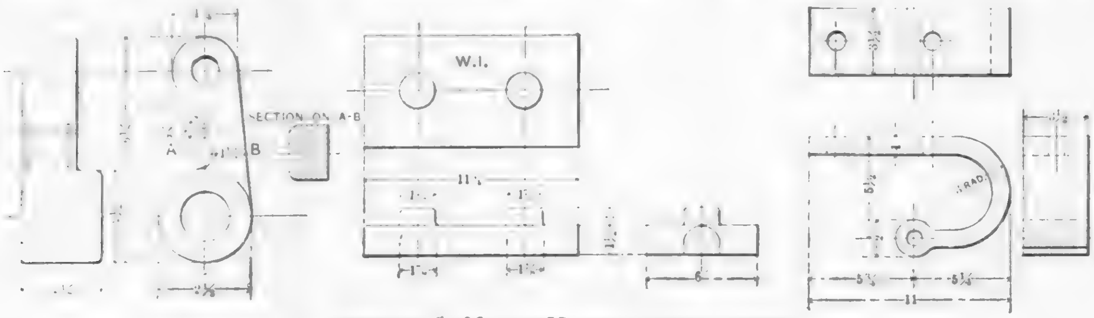

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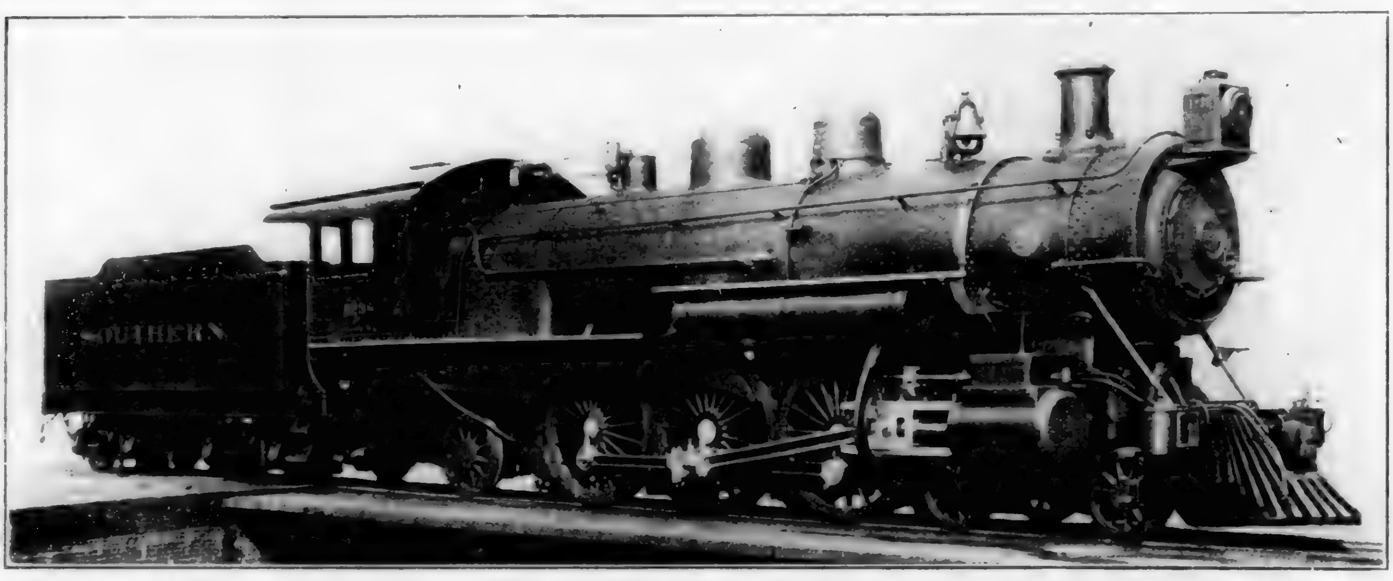

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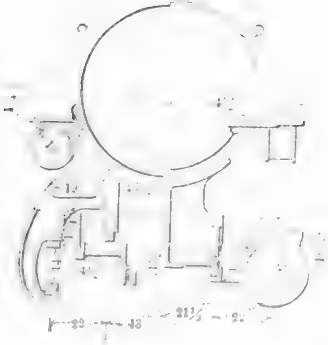

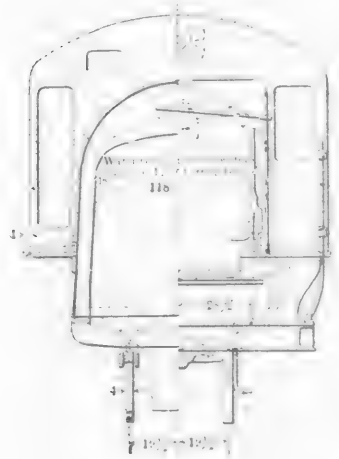

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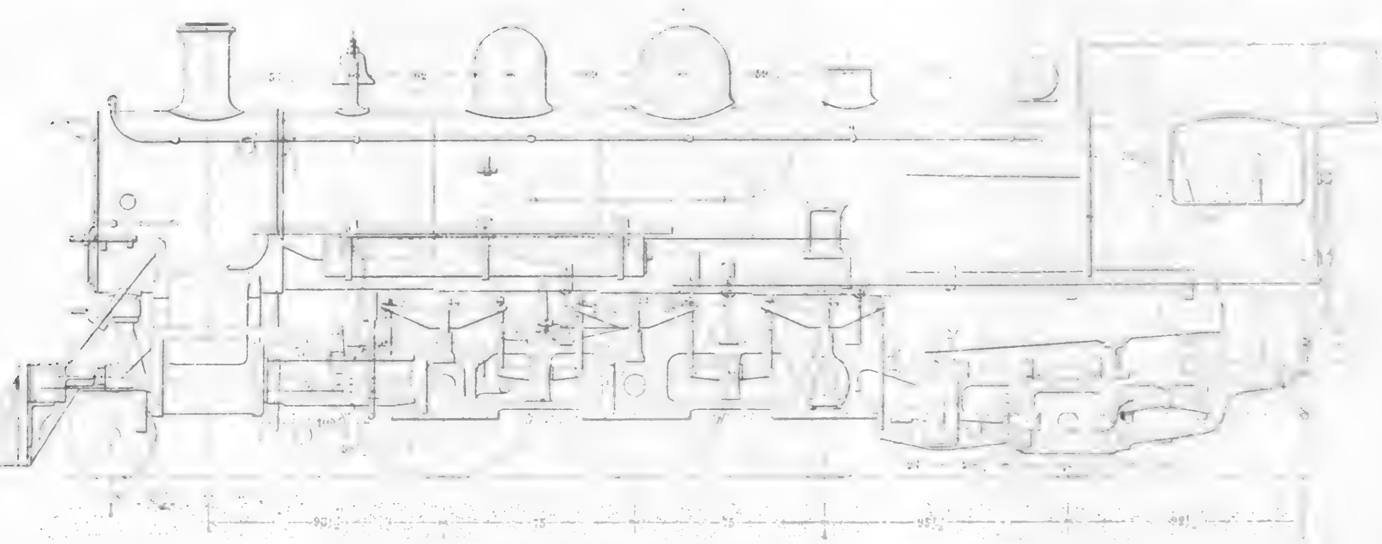

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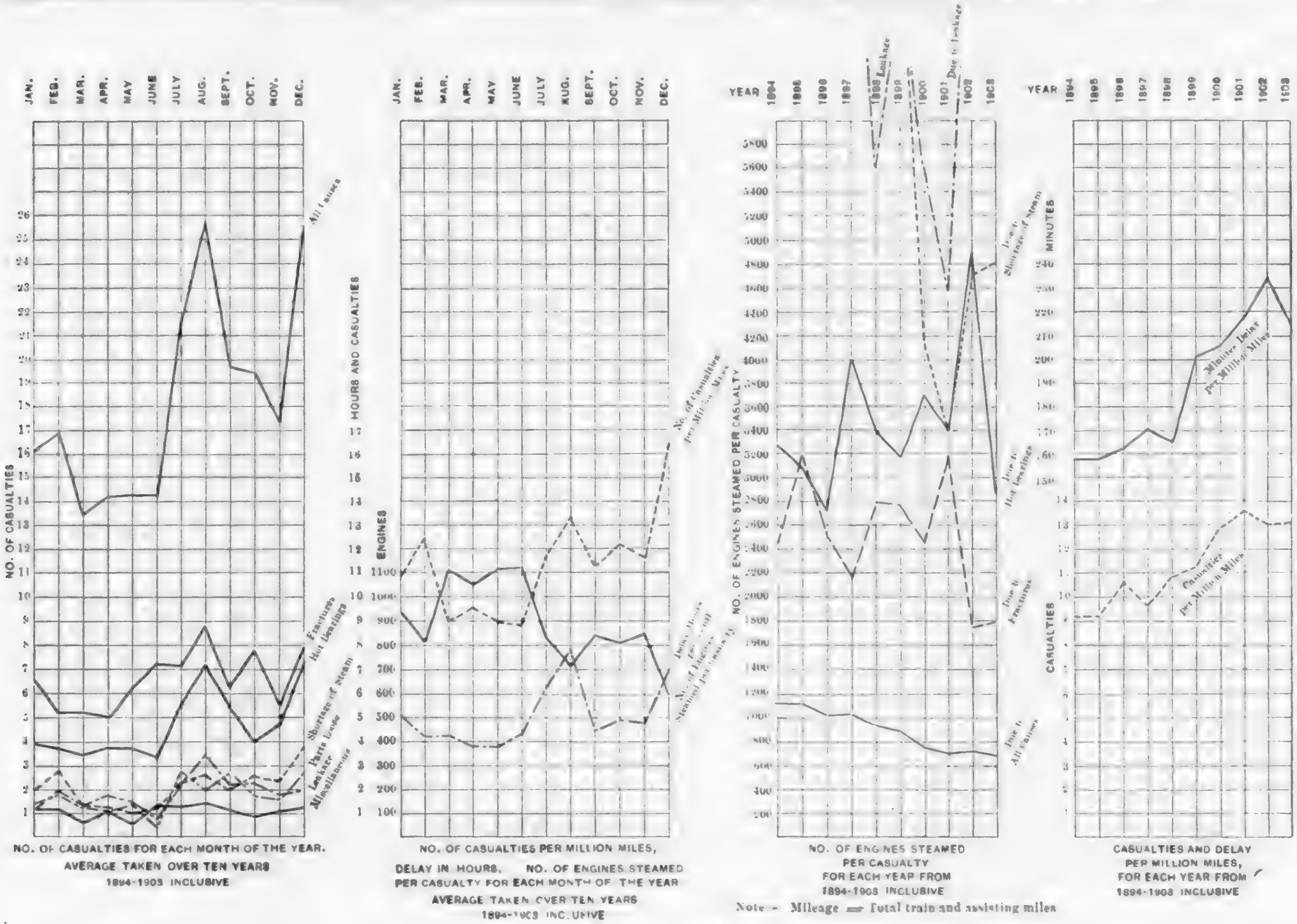


PASSENGER LOCOMOTIVE FAILURES.

A TEN YEARS' RECORD OF LOCOMOTIVE FAILURE.

Several references have been made in this journal to the care which is given to English locomotives and their consequent freedom from breakdowns. One of the English roads having somewhat less than 3,000 locomotives and a track mileage of about 2,500 miles, recently made a careful study of its locomotive casualties, as contained in the reports to the secretary covering a period of ten years and including locomotives in passenger and freight service, under separate headings. This unique study presents interesting information as a basis of a study of the changes in conditions of operation in England and American railway officials may see in it an example of the value of the care, in the matter of running repairs for which English railroads are noted.

The English term for locomotive failure is "casualty," and in these reports only those cases are included in which time has been lost by actual inability of the locomotive to perform its required task through some defect in itself or mismanagement on the part of the men in charge of it, or for any fault in which a locomotive department may be properly held accountable. In the passenger record each case is recorded when the net delay is three minutes or over, which is not made up. The freight record shows net delays of three minutes or over on the same basis. In this record the careful student will find that the number of cases in which trains had to be given up by the engine men to be a very large proportion, very much larger than is the case in this country. This seems to indicate the difference between our admittedly ineffective care of locomotives, which tends to allow many of them to get into a condition so as to pull their trains indifferently, and thus maintaining them more nearly on the ragged edge than is the case in England. About 60 per cent. of the breakdowns in this record are of such a character as to put the locomotive temporarily out of business. They were real breakdowns.

The records will be considered separately for passenger and for freight, and in each case a diagrammatic summary is presented, which speaks for itself.

PASSENGER SERVICE.

These records cover the years from 1894 to 1903 inclusive. They are grouped under the following heads:

1. Fracture or other failure of material. This includes burst tubes; breakage or distortion of any part or stripping the threads.

2. Hot bearings includes over heating of any working part by friction.

3. Shortage of steam includes everything due to a failure to maintain steam pressure.

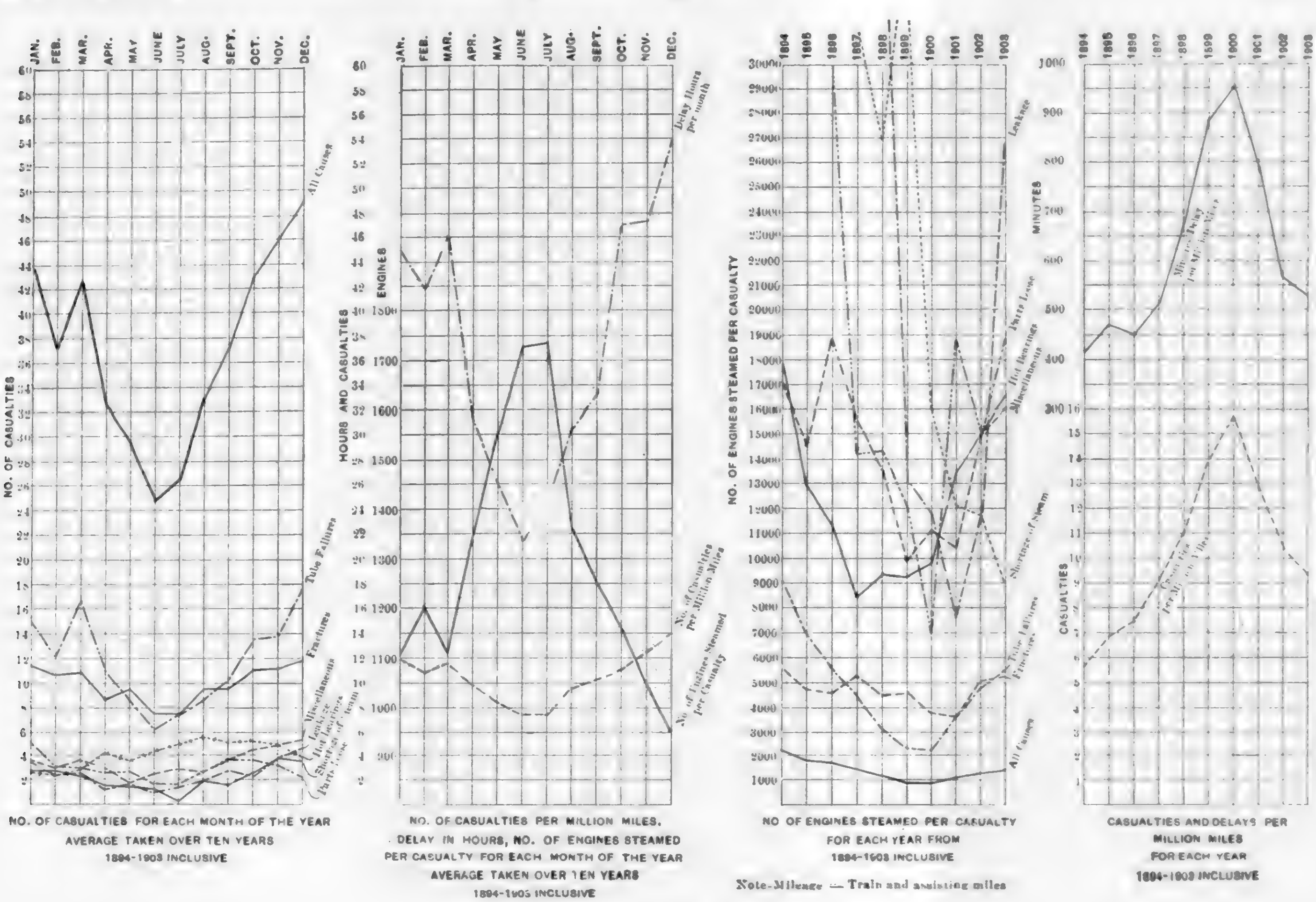
4. Leakage includes all cases of leakages of steam or water either from the boiler or the tank which cannot be included in any of the other groups, such as from riveted joints, slack tubes, loose manhole covers, packing, piston valves, water valves and all kinds of joints.

5. Parts becoming loose or detached includes all cases in which the casualty should be primarily attributed to any part becoming loose or detached, such as the falling of the brick arch, steam joints blown out; the pins or collars working out.

6. Miscellaneous cases include all cases which could not be clearly placed under any of the foregoing heads such as defective injectors, sanding apparatus or shortage of water.

The summary of the above classifications, with the exception of the shortage of steam, shows the following results: Under fracture or other failure of material there are 797 casualties during the ten years or 36 per cent. of the total. Hot bearings accounted for 568 casualties or 26 per cent. Shortage of steam 255 cases or 11.6 per cent. Leakage 230 cases or 10.4 per cent. Parts becoming loose or detached 217 cases or 9.5 per cent. Miscellaneous cases 135 or 6.2 per cent.

The total number of casualties for the ten years aggregated but 2,202 for the entire passenger service on one of the best



FREIGHT LOCOMOTIVE FAILURES.

known railroads in England. The number of passenger locomotives concerned cannot be stated without violating the confidential understanding under which this record is presented.

During the ten years under survey the passenger engines were steamed 1,920,377 times. The total delay from casualties aggregated 610½ hours, an average of about 16 minutes delay per casualty, and one casualty for every 870 engines steamed. Imagine the passenger locomotives of an American railroad operating so that in ten years 870 engines would be steamed for one delay of three minutes which the engines could not make up!

Under fracture or other failure of material burst tubes accounts for 29 per cent. and valve gear failures for 12 per cent. Connecting rod ends account for over 66 per cent. and hotboxes for 23 per cent of all the hot bearings. Leaky tubes account for 80 per cent. of the leakage. The falling of brick arches accounts for 29 per cent. and the failure of damper rigging for 8 per cent. of all the parts becoming loose or detached. Failure of injectors or injector apparatus accounts for 50 per cent of the miscellaneous cases and half of these are due to check failures.

The average number of casualties in which trains were given up by the engine men amounted to 63.4 per cent. for the ten years or roughly two out of every three cases. The diagrammatic record shows the casualties for the ten years by years. From 1894 to 1903 the number of casualties has gradually increased not only in number, but the number has increased in proportion to the miles run and the number of engines steamed.

Shortage of steam became serious in 1900 and was at its worst in 1901. Comparing the years 1894 and 1903, and considering casualties due to all causes there were 37 per cent. fewer engines steamed per casualty, and 35 per cent more time lost per million miles and 41 per cent. more casualties per million miles in 1903 than in 1894. This suggests a decreased efficiency, which has been gradual throughout the ten years for which, no doubt, there are many contributary causes, such as increased steam pressure, higher speeds, longer runs and more exacting conditions under which trains are now worked.

In making up the synopsis it was found that 36 per cent. of the casualties could be considered accidental, 20 per cent. were due to wear and tear, while the engine men were to blame in only 12½ per cent. of the cases. This study revealed opportunities for improvement in design. The report from which these interesting figures were taken discusses suggested improvements, which will undoubtedly be reflected in the report for the next ten years.

FREIGHT SERVICE.

With the exception of keeping a separate record of casualties, due to burst and leaking tubes, the freight record followed the plans of the passenger record, with the same subdivisions. The diagrams in both cases show the fluctuations. There were 4,963 casualties in ten years, the number of engines steamed being 5,536,869 with an aggregate delay of 4,481¼ hours or one casualty per 1,245 engines steamed and an average delay of 60½ minutes per casualty. Trains were given up on 3,159 occasions or an average of 71 per cent., the record showing that during the last four years the casualties have apparently been of a less serious nature than formerly. Naturally, the highest number of casualties occurred during the winter, from October to March, and the fewest in May, June and July. Taking the years separately there was a gradual rise in the number of casualties per million miles from 1894 to 1900, but since that year the figures have steadily improved, the year 1903 being slightly better than the average for the whole of the ten years.

A summary of the causes shows a total of 1,204 casualties

or 27 per cent due to fracture or other failure of material. Burst or leaking tubes accounted for 1,420 or 32 per cent. Hot bearings 491 cases or 11 per cent. Shortage of steam 264 cases or 5.9 per cent. Leakage 297 cases or 6.7 per cent. Parts becoming loose or detached 371 cases or 8.1 per cent. Miscellaneous cases 416 or 9.3 per cent. The accidental causes number 1,274 and wear and tear accounted for 1,630. Engine men were found to be at fault in only 381 cases. There were 142 cases of flaws in material and 220 cases of other flaws which were hidden.

Some of these figures are difficult to credit, except through knowledge that English locomotives are, as a rule, operated well within their limits of capacity, the very life not being pounded out of them as it is in some other countries which could be mentioned. There is a lesson in this investigation entirely aside from those to be learned from the reports themselves; viz., that a study of this kind is a most valuable check upon engineering as applied to the locomotive. If an English locomotive is in bad order it is held in the engine-house and fixed, its place being taken by one that is in proper order. English train service could not be handled in any other way.

American railroad officials should make a study of this record as a preparation for similar study of their own practice.

POWER REQUIRED BY MACHINE TOOLS, WITH SPECIAL REFERENCE TO INDIVIDUAL MOTOR DRIVE.

By G. M. Campbell.*

(Continued from Page 108).

There is a class of machines where the size of motor required depends very largely on the machine itself, almost independent of the size of cut it has to take, this is the reciprocating tool, as the shaper and planer and to a somewhat less

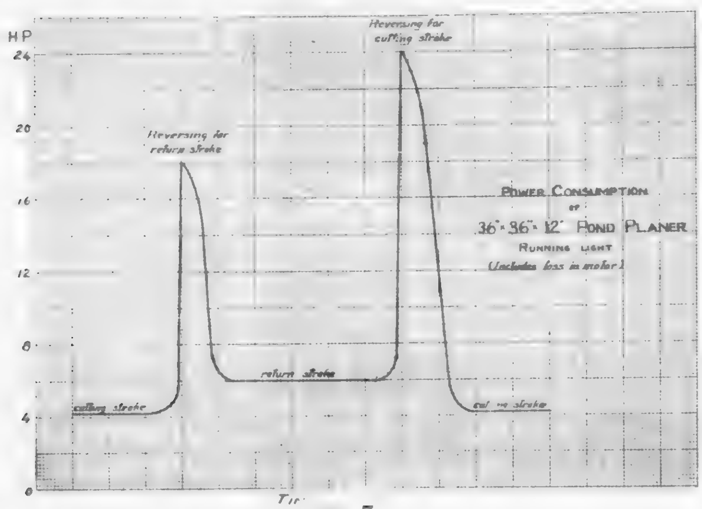


FIG. 7.

extent the intermittent working machines, such as punches and shears. In planers where shifting of belts is relied on to reverse the motion, the statement is fairly accurate; in tools where the reversal takes place by magnetic clutches or motor reversal it is not so much so, as the power taken by the motor can be better regulated. In planer drives, where the motor runs continuously in one direction, it is of relatively little importance how much the platen or the load on it weighs, but the size and weight of the revolving pulleys which have to reverse it is of very great importance. These pulleys should be as small and light at the rim as capacity will allow; and on one of the revolving shafts, preferably on the motor shaft, there should be a flywheel of large diameter and heavy rim so as to aid the motor at moment of reversal.

Fig. 6 is for a 60-in. by 60-in. by 20-ft. Pond planer. The cycle of power consumption is rather remarkable, but is a fair example of tools of this class and method of drive, reversal by shifting belts. These readings were taken with the machine running light. During cutting stroke the horse power taken was 3.9, reversing to return stroke the power jumped to 19; on the return stroke it was 6.3 and in reversing to cutting stroke it rose to 27.0. Speed of the table in cutting stroke about 25 ft. per minute; on the reverse stroke, 60 ft. per minute. This planer was driven by a compound wound Crocker-Wheeler motor 73.5 amperes, 20 h.p. at full speed and voltage rating. The flywheel on this machine is much too small, but, owing to special design of the driving mechanism, it could not be increased. The driving mechanism would have to be improved considerably to make it suitable for much higher speeds.

Fig. 7 is of some tests on a 36-in. by 36-in. by 12-ft. Pond planer on exhibition at St. Louis Exposition. This machine was driven by a reversing motor, belts being entirely done away with. The same general cycle is evident. Horse power, 4.1, to 18.0, to 6.0, to 24.0 and back to 4.1. Speed of table cutting stroke was 32 ft. per minute, return stroke 75 ft. per

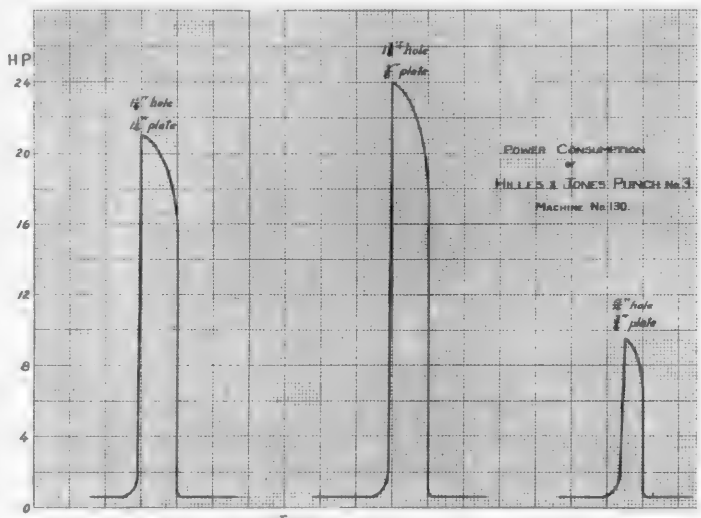


FIG. 8.

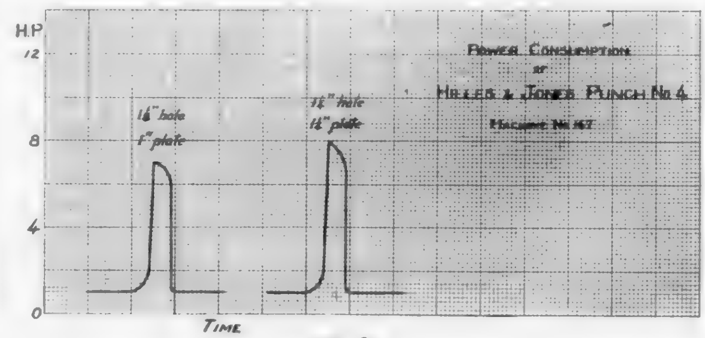


FIG. 9.

minute. The horse power in this curve includes the power losses in the motor itself which are not included in any of the other cases. This planer was driven by a No. 7, 6-h.p., type S, Westinghouse motor, speed range 4 to 1, rating 48 amperes at 110 or 220 volts. Loads obtained in taking heavy cuts were considerably in excess of the rating of the motor. In comparing the horse power rating of the motors on these two planers, the relative ratings given in Fig. 1 must be borne in mind; they are not rated on the same basis.

Influence of design on the power required for punches and shears is well brought out by Figs. 8 and 9; each machine was used, for example, for punching a 1¼-in. hole in a 1¼-in. plate. In the lighter machine, Fig. 8, the horse power rose to 21, while in Fig. 9, only to 7.9, showing very clearly the influence of the heavy flywheel and gear in the latter machine.

In the shops of the P. & L. E. R. R., at McKees Rocks, there are about 80 machines driven by individual motors. For vari-

*From a paper read before the Mechanical Section of the Engineers' Society of Western Pennsylvania.

able speed work, the speed variation required in the motor was, in general, about 2.8 to 1 for full power, but up to from 6 and 7½ to 1 for diminished power at low speeds, and the size of motor was approximately double the horse power required by the machine throughout this full power range, i. e., if the motor was rated as a variable speed motor, it would have a rating approximately one-half that of the constant speed rating. The speed variation in many instances differed considerably from the above. In many of the drills, the speed variation was higher and in planers, shapers, etc., lower. As has been brought out in previous papers read before this society, the speed control in these shops is obtained by means of the multi-voltage system. The horse power required by the machine was determined partly by general considerations and partly by the formula stated above, HP = KW, where K had a value of 3.6 for hard steels and 2.5 for soft steels. From data given on previous pages, it may be seen that the size of this constant was on the safe side. All machines are protected by both circuit breaker and fuses; the size of the breaker was, in general, 4 amperes per rated horse power of the motor and it was set at the limit of 50 per cent. above this rating, the breaker would therefore fly out when the power consumption was approximately 100 per cent. overload. On reciprocating tools, the circuit breaker was set 40 to 50 per cent. higher. The enclosed fuses used had a rating the same as that at which the circuit breakers were set.

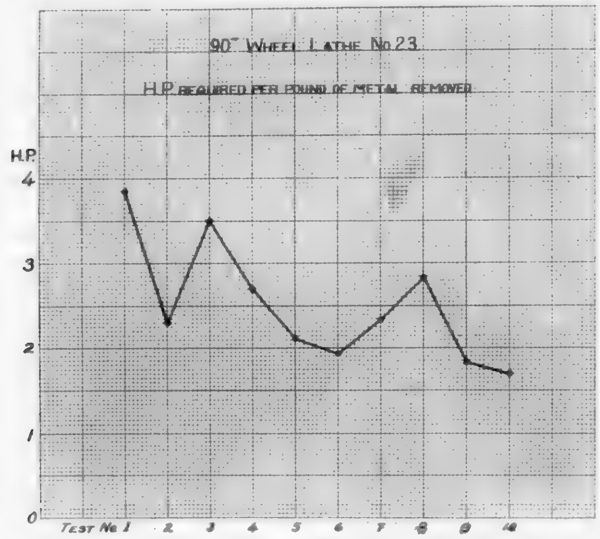


FIG. 13.

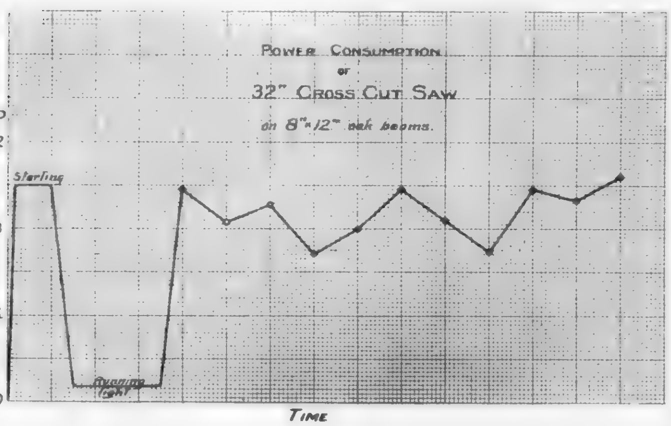


FIG. 16.

After the plant was in operation a large number of tests were made, every machine listed being tested to see whether or not the motor capacity was sufficient. (For list of machines and motors see AMERICAN ENGINEER AND RAILROAD JOURNAL, page 341, September, 1904). In no case is the motor too small. In a few cases the motor could easily be reduced for P. & L. E. R. R. work; in general, the sizes are such as would be used providing the size of motors had to be fixed over again.

On a 90-in. driving wheel lathe, after eliminating the power lost in friction given in Fig. 4 and in the motor, practically the same as in Fig. 11, the horse power required to remove one pound of metal is given in Fig. 13; the amount varies from 3.87 to 1.70, certainly a very wide range, but the grade of steel also varies widely.

As to the power required by wood working tools, the writer has formulated no general rules, a few sample power readings will be given to show the power required in certain machines. The power consumption in wood working tools is very large, very much larger than one might ordinarily expect. In adapting these machines for motor drive, the motor should have ample capacity when the machine is to be used continuously in a manufacturing shop. Fig. 15 gives the power required to drive an 8 in. by 24-in. Fay planer reducing a 6½ to 6¾ in. by 12-in. and a 6¾ to 7 in. by 12-in. oak beam to 6 ins. by 12 ins. Power required starting machine was about 25 h.p., running light, 5.7 h.p. The power under cut includes the power loss running light. Readings were taken about 15 seconds apart. Fig. 16 is for a 32-in. cross cut saw, sawing 8 by 12-in. oak beams. Fig. 17 is for 30-in. rip saw, first part taking cut 6 ins. deep in dry oak, second part 8 ins. deep in very wet oak.

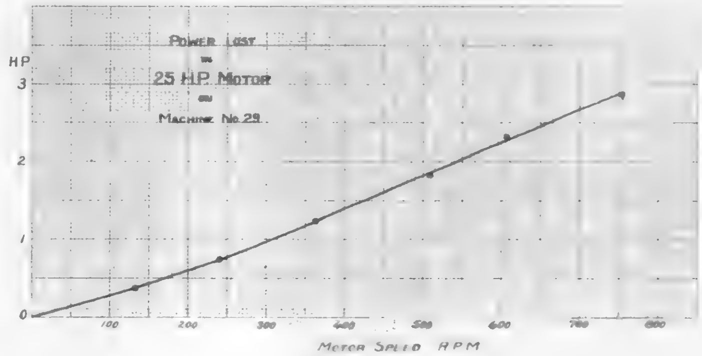


FIG. 11.

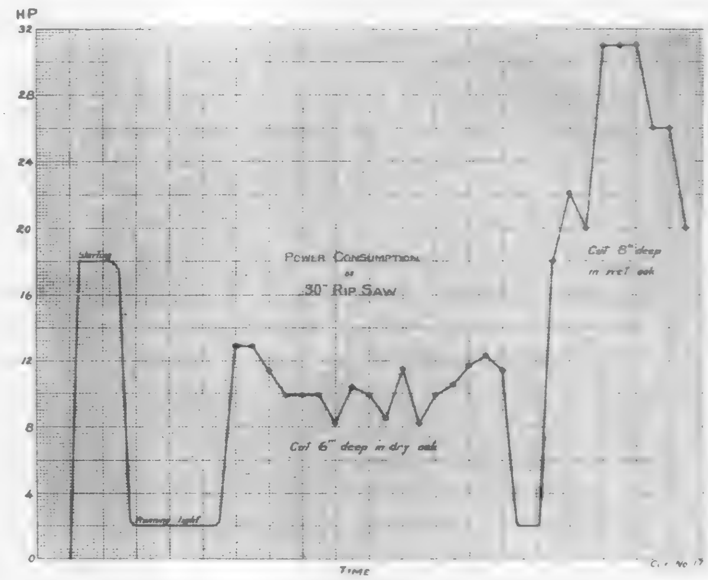


FIG. 17.

The total power lost in the motors and lost in friction in the machines is considerable, even though in individual cases it is not very large. To investigate this point, among others, some experiments were made on a Sunday when the shops were idle. Forty-six machines were selected, every one equipped with an individual motor capable of speed variation. The machines were as follows:

Machines.	Horse Power Rating of Motors.
17 Lathes	215
5 Milling Machines and Boring Mills	70
5 Planers	66
5 Slotters and Shapers	[illegible]

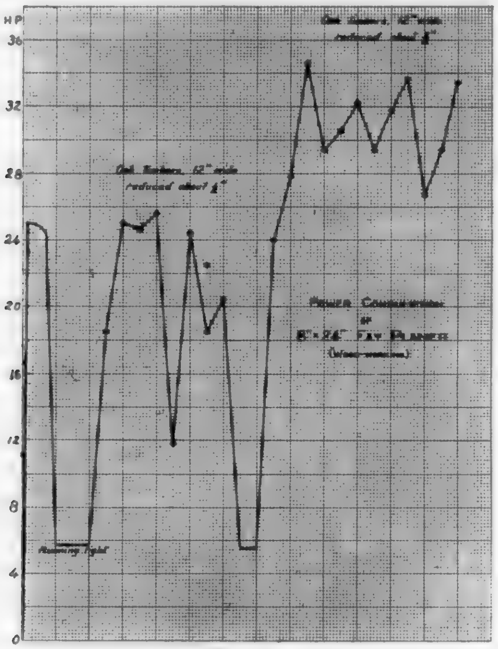


FIG. 15.

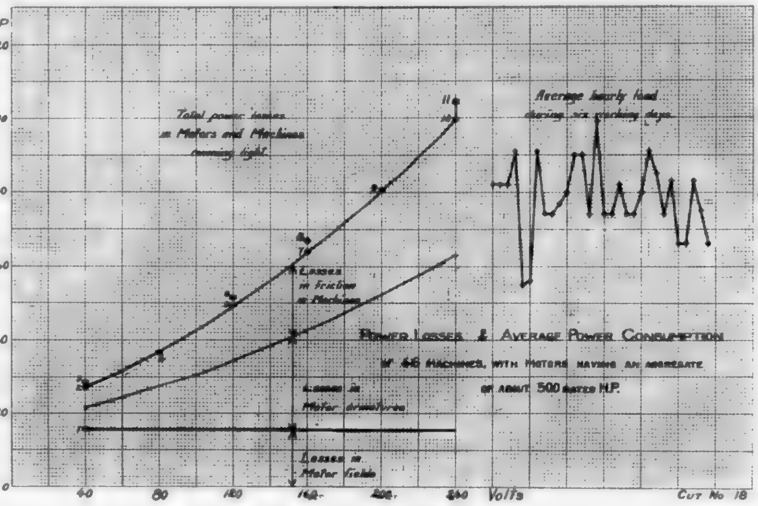


FIG. 18.

9	Drilling Machines	50
5	Punches, Shapers, Rolls, etc	61
46		497

First, full current strength was put on all the fields, then all the motors were run on the 40-volt circuit, then all on the 80-volt circuit, 120-volt, 160-volt, 200-volt and 240-volt in turn, and finally lathes and drills were run on the high-speed point, approximately 30 per cent. above normal 240-volt speed, power consumption being noted at all the different points. All machines driven by these motors were in motion, but no work was being done, nor was feed mechanism in use. The results are tabulated in Fig. 18; planer platens were not operating except for points 3, 6, and 8. The curve giving losses in motor armatures was plotted from readings on a number of motors disconnected from machines. The speed of the motors varies approximately as the impressed voltage, so it will be seen that after deducting 15.2 h.p. for the fields, the horse power lost in the motor armature and tool varies approximately as the speed. It will be noted that when all these forty-six tools were running at top speed, no useful work being done, the lost horse power was 105 lbs. The full losses given are never incurred, as the tools are never all running at one time and never all on the top motor speed; in fact, the average or even the maximum power consumption on any working day when all the tools are working is less than the maximum for lost power alone. The part of the curve at the right hand in the cut is the total power consumption for all the tools included above and a few constant speed motors besides. These readings were taken every two hours during the six working days succeeding the Sunday on which the readings for power losses were taken.

The record is not quite complete, as it does not give the gear reductions in use; some of the machines were using high speed, some low-speed gears. If all the machines had been run on the highest speed gear the loss in friction in the machines would probably have been doubled.

A large number of special conditions may enter into the determination of the size of the motor required for any particular tool, the class of work it is to be restricted to, the grade of material, whether cuts, if heavy, will be of short duration, etc., so that it is rather difficult to make a statement that will fit all cases, but the writer would suggest the following for determining size of motor for average conditions—assume a cutting speed of 50 to 70 ft. a minute for soft steels, estimate the maximum size of cut that will likely be required for any time longer than 30 minutes, transfer this into pounds of metal removed per minute, and multiply by 2.7 (this figure is 50 per cent. above the constant 1.8 used previously in this paper, the increase being for safety for bad conditions), then select a motor which will develop this power throughout the range of speed desired.

WESTINGHOUSE TYPE "K" TRIPLE VALVE.

This valve, which was first publicly introduced at the West Seneca tests on the Lake Shore & Michigan Southern Railway last October, is new more in designation than in detail, since it consists of an ordinary Westinghouse quick-action freight triple valve with a small addition and slight modifications in the ports of the valve body and slide valve, designed to meet those conditions existing in the long-train service of the present day, which are not met with entire satisfaction by any present standard triple valve. Any Westinghouse freight triple valve can be made over into the "K" type with very little expense and during the usual time required for general repairs. The principal advantages gained by such modifications are:

1. Quick action in service applications.—This is obtained by venting a certain amount of brake-pipe air to the brake cylinder at each triple valve during the service applications in a way similar to the emergency applications of the old triple valves, with less danger of undesired emergency applications and with a greater degree of sensitiveness of graduation than can be obtained in the present standard valves.

2. Retarded release of brakes on the forward part of the train.—This extremely desirable result is accomplished through an arrangement of ports in connection with a spring affecting the movement of the piston and slide valve in the release position in such a way that either a full or restricted exhaust port can be obtained, as the position of the car in the train requires.

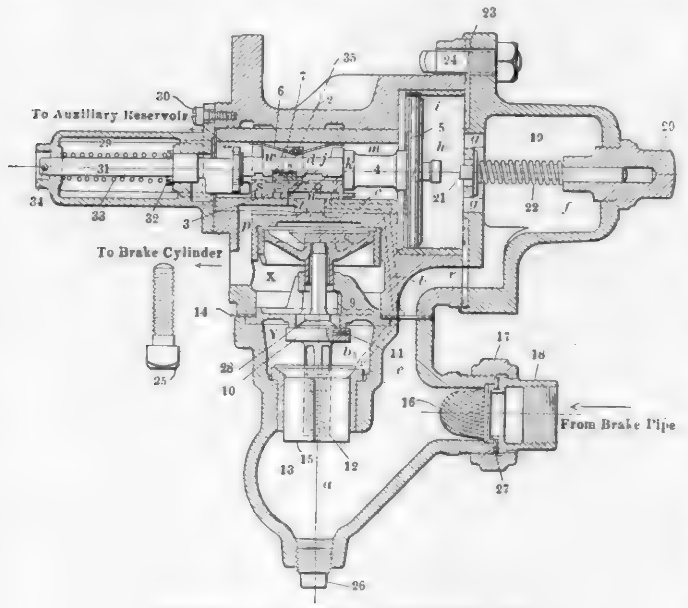
3. Even recharge of auxiliary reservoirs throughout the train.—The "feed port" is so changed in relation to the triple-valve piston that its opening is reduced on such triple valves as are in the "restricted-exhaust" position, while those having the full exhaust opening also have the full recharging opening. This provides that all the brakes in the train may be recharged in about the same length of time.

These very desirable results have long been sought after but never before obtained in a practicable shape. The quick-service feature insures a much more rapid response to service applications of the brakes on all lengths of trains. With the old triple valve on a fifty-car freight train, it is necessary, in order to be sure that all brakes will apply, to make not less than a 7-lb. brake-pipe reduction. With the "K" triple valves under such conditions, a 5-lb. reduction will readily apply all brakes, thus materially reducing the loss of air from the brake pipe during an application. More than that, a reduction of pressure such as will insure the application of all the brakes

on a fifty-car train with the old style of triple valve develops only a small cylinder pressure on the rear cars of the train, while the new valve causes a pressure which is approximately equal on all the cars.

On a 100-car freight train it is impossible, with any present make of triple valve, to apply all the brakes with any service application. This applies even where the triple valves are all in first-class condition. With the "K" triple valve, however, no trouble is experienced in applying all of the brakes on this or even a greater length of train. With the ordinary triple valve on such a train, a 15-lb. brake-pipe reduction applied from 76 to 81 brakes with Westinghouse triple valves used with 8x12-in. brake cylinders. With the 10x12-in. brake-cylinder equipment, the number of brakes that will apply under similar conditions is considerably less than with the 8-in. With the "K" triple valve and its quick-service feature, however, a means of applying all the brakes is afforded with lighter brake-pipe reductions than are required with the old triple valve giving the unsatisfactory results above mentioned.

This retarded-release feature provides a means by which



WESTINGHOUSE TYPE K TRIPLE VALVE.

the brakes can be released at slow speed without any danger of train partings. With the present equipment it is often necessary to bring freight trains to a standstill before releasing the brakes if the speed has been reduced to ten miles an hour or less, and under certain conditions this speed limit is even greater. In many cases, where spring draft gear is used, it is not practicable to release at slow speeds even when the engine is equipped with the independent straight-air brake, the latter being used to control the slack of the train. By proper manipulation of the brake-valve handle, this retarded-release feature puts into the hands of the engineer a means of (1) releasing the brakes at the rear end of the train first; (2) releasing those at the head end first; or (3) releasing the brakes throughout the train all at the same time.

The restricted recharging of the brakes on the forward cars causes the air pressure to rise more rapidly throughout the entire brake pipe and makes more air available in a shorter time for releasing and recharging the rear brakes. This effectually obviates the tendency of the rear brakes to stick, because this tendency is due to the auxiliary reservoirs on the forward end absorbing so much of the air while recharging that the rear cars do not get the presssure required to promptly release their brakes. It also prevents reapplication on the head and after release, due to the brake-pipe pressure there being lowered through the rear brakes still recharging after the forward ones are fully charged.

This feature also permits of the brake-valve handle being allowed to remain in the release position longer without overcharging the head of the train, thus more quickly building up the brake-pipe pressure, and, consequently, recharging the auxiliary reservoirs. Since those brakes at the rear of the train are charged up in about the same time as those at the head end, a more evenly distributed braking power is obtained, causing each brake to do its share of the work and avoiding the overheating of certain wheels.

A fifty-car freight train equipped with the new valve and running at a speed of 20 miles per hour, will be brought to a standstill by a 5-lb. brake-pipe reduction in about 400 ft. shorter distance than with the old type, due to the more prompt application, higher average cylinder pressure and more positive action of the brakes. It requires a 20-lb. reduction with the old triple valves to stop in the same distance as the 5-lb. reduction just mentioned. More than this, the amount of free air saved on a fifty-car train with 10-in. brake equipment, due to the lighter brake-pipe reductions and quick-service feature, is about 25 cu. ft. for every full application. And a full application with the new valve stops the train in 35 per cent. less distance than required with the standard valve.

The present standard Westinghouse freight triple valve may be transformed into the improved type by a simple change, preserving all the old parts except the body, slide valve, slide-valve bush and graduating valve. This can be done when these valves are sent to the brake works for heavy repairs. Thus the cost of re-standardizing is reduced to a minimum, the time required will not exceed that allowed for ordinary repair work, and the railroads will get the advantage of using the parts of their own triple valves.

The accompanying illustration is a central vertical section through the "K" triple valve, from which the changes required to convert the old standard valve into this type will be readily understood. These changes are: a new body, *2;* a new slide valve, *3;* a new graduating valve, 7, of the slide valve type; the necessary modifications in the piston stem, *4*, required by the new type of graduating valve; the new slide-valve bush with proper re-arrangement of ports to suit the new slide valve, and the addition of the retarded-release feature, *29*, which, in the ordinary freight equipment, protrudes into the auxiliary reservoir volume. Besides this, the port *b* is drilled through the body and check-valve case in such a manner as to connect the chamber *Y* above the check valve to a port in the slide-valve seat. In the release position of the valve when used with the 10-in. brake equipment, this port *b* communicates through a port in the slide valve with the slide-valve chamber, and thus with the auxiliary reservoir, permitting air from the brake pipe to raise the check valve *15* and pass through port *b* to the auxiliary reservoir. This in addition to the supply that passes through the ordinary feed groove *i* around the piston, so that in full release position the auxiliary reservoir will charge very rapidly. But if the valve is in the retarded-release position, port *b* connects with a much smaller port through the slide valve, while the piston fits closely against the ends of the slide-valve bush, cutting off any supply through feed groove *i*, thus greatly reducing the rate of recharge. This also applies to the valve when arranged for an 8-in. equipment, except that communication between port *b* and the slide-valve chamber is broken during the full release, all the air for recharging then coming through the feed groove, while during the retarded release the port in the slide valve which opens *b* to the slide-valve chamber is about half the area of the feed groove. This difference exists because of the different volumes of air that have to be handled, while the feed grooves in both valves are the same size.

The retarded-release feature is made possible through the supplementary portion, *29*, which consists of a brass frame casting open on both sides and attached to the triple-valve body by means of three screws, *30;* the stem, *31*, acts as a stop for the triple-valve piston when moving to the release position. Since it is held to its position by the spring, *33*, and collar, *32*, it will readily be seen that by properly proportioning this spring, the stem, *31*, can be made to compress the spring or not, depending on the rate of increase of the brake-pipe pressure in chamber *h*. If the triple valve is on the head

end of the train, where the brake-pipe pressure builds up rapidly, spring, *33*, will be somewhat compressed by the piston when going to the release position, thus allowing the slide valve, *3*, to pass beyond full release position and partly close the exhaust port. As the brake-pipe pressure equalizes throughout the train, and feeds through into the auxiliary reservoirs, the difference of pressures on the two sides of the piston becomes less, and the slide valve is gradually forced back to the full exhaust opening.

The quick-service feature is gotten through port *b*. When the slide valve goes to the service-application position, its arrangement of ports is such that the chamber, *Y*, is connected through port *b* to the brake cylinders. These ports are so restricted that the resulting flow of air from the brake pipe to the brake cylinder through port *b* is not sufficient to cause an emergency application, but will materially hasten the brake-pipe reduction throughout the train. It is for this reason that a much smaller reduction is required at the brake valve to obtain a given brake-cylinder pressure than would be the case with the old type of triple valve. This is true not only because of less air exhausted to the atmosphere at the brake valve, but also because of the additional pressure derived from the air entering the brake cylinders from the brake pipe and thereby causing a higher brake-cylinder pressure.

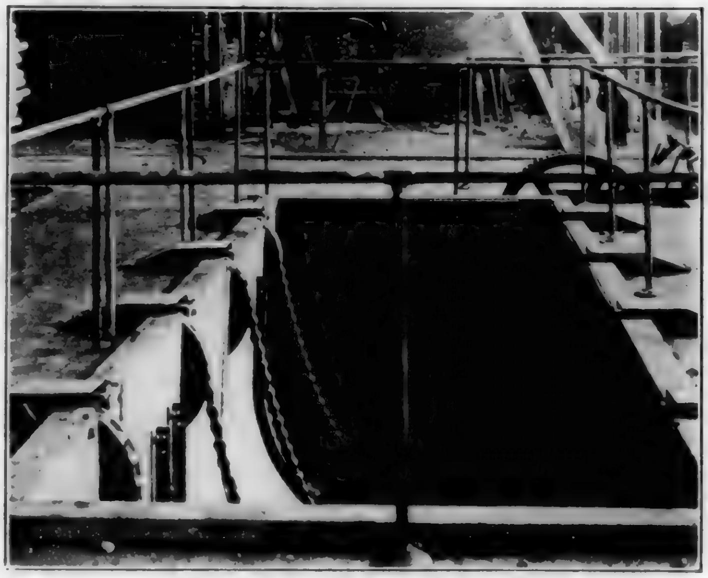
In all other respects the operation of this valve is practically that of the present F 36 or H 49 triple valves. Its outward appearance, when attached to the auxiliary reservoir, is so much like these valves that, to distinguish it, a thin lug is cast on the top of the body in a position easily seen from the side of the valve; and its designation "K-1" or "K-2" is also cast on the side of the body, the former replacing the F 36 and the latter the H 49 standard valves.

A large number of these valves are already in service, giving results that are in every way satisfactory. The serious problems brought forward by the rapidly changing conditions of freight service have made it absolutely necessary to increase the power and flexibility of the air brake. Yet the adoption of any new device would entail such an immense amount of expense and inconvenience; that the arrangement above outlined whereby the valves now in service can be utilized and transformed to give the required results with only a slight addition to the number of parts and with little expense, will prove to be one of the most important improvements yet brought out in connection with air-brake equipments.

COMPARATIVE SAFETY OF TRAVEL IN UNITED STATES AND ABROAD.—I have collected some data from other sources, and have, as far as possible, verified it. During the year ending June 30th, 1903, the total number of passengers killed on railroads operating in European countries was 536; in the United States these figures aggregated 321. The mileage of the European roads was 177,363, and in the United States 207,977 miles, so that for every 331 miles of road in Europe during this period you will note one passenger was killed, as against one passenger to each 648 miles in the United States, which suggests the conclusion that fatalities to passengers are not greater on American than on foreign railways. In point of fact, during the period mentioned, such fatalities seem to be at the ratio of 2 to 1 in favor of United States railways.—*Mr. W. G. Besler, New York Railroad Club.*

NEW MACHINE FOR CLEANING FLUES.

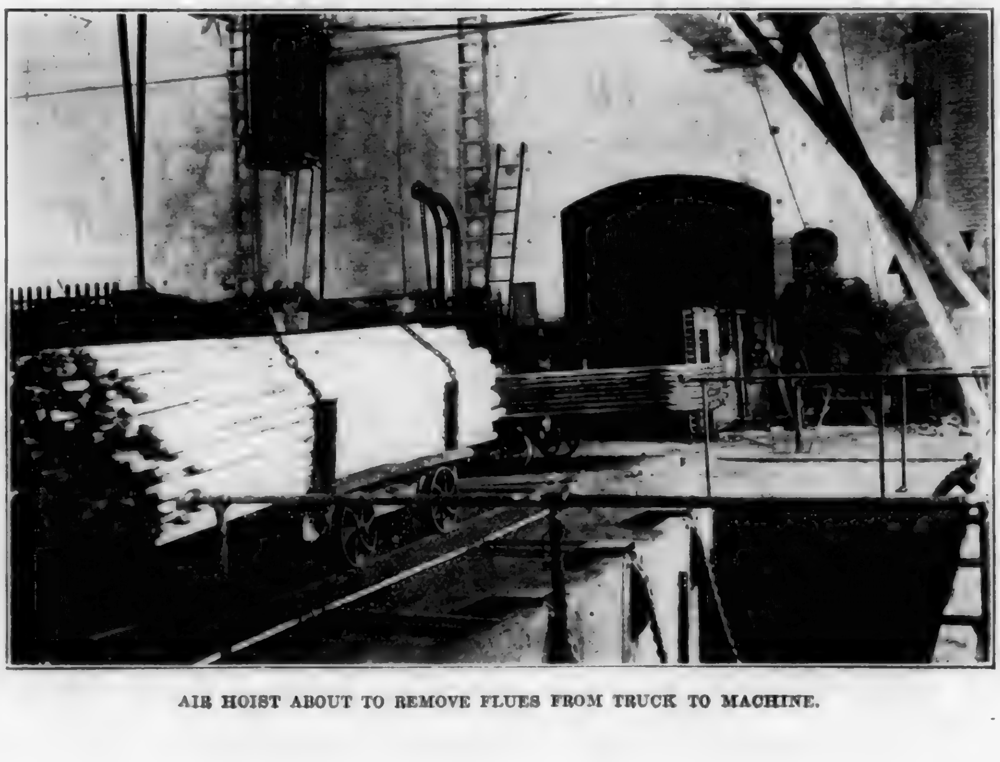
A new machine for cleaning flues has recently been installed at the South Tacoma shops of the Northern Pacific Railway, which is similar in principle to those in use at the Topeka shops of the Atchison, Topeka & Santa Fe Railway and the Angus shops of the Canadian Pacific Railway, the construction and operation of which were fully described and illustrated on page 221 of the AMERICAN ENGINEER AND RAILROAD JOURNAL, June, 1904. The advantages of these machines are that they will clean a larger number of flues at one time and clean them quicker than by other methods. As the flues



NEW MACHINE FOR CLEANING FLUES.

are rolled under water the noise is greatly reduced. The cost of handling the flues in and out of the machine is reduced to a minimum.

The overhead works have been done away with on the machine at South Tacoma, making it more compact and convenient. Instead of having only two sprocket chains, one of which is adjustable to suit the length of the flues, there are four sprocket wheels mounted on a shaft on each side of the tub, or tank, as shown in the illustration. These sprocket wheels are so placed that the chains will clear the sides and



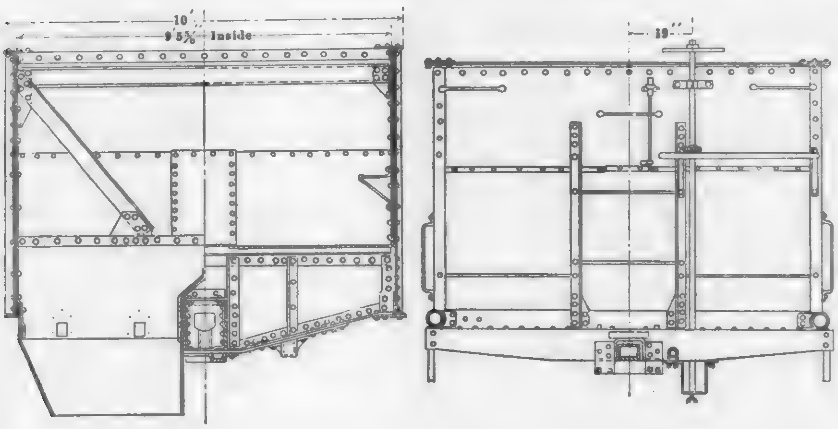
AIR HOIST ABOUT TO REMOVE FLUES FROM TRUCK TO MACHINE.

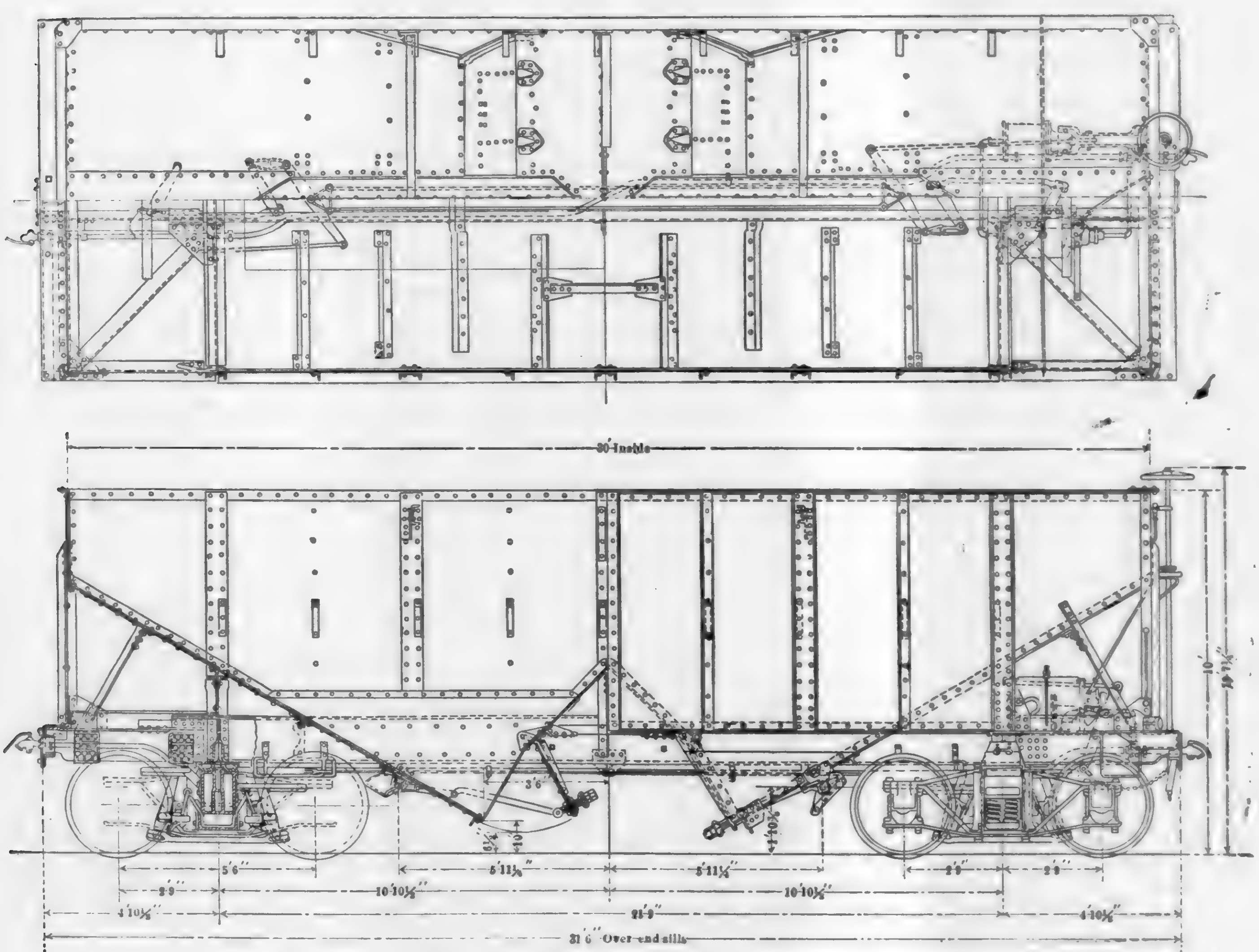
bottom of the tank by about 6 ins. The tops of the sprocket wheels are about level with the floor line. There are a number of idlers at the bottom of the tank, so situated that the brackets upon which they are mounted answer for the legs of the tank and allow about 1 in. clearance for the chain to pass under the bottom of the tank.

The flues are raised and lowered into the tank by means of an overhead trolley air hoist. The chains which handle the flues are allowed to remain in the tank during the process of cleaning, so that it is only necessary to attach the hoist to the chains when they are ready to be removed. One of the illustrations shows a truck load of 378 2-in. flues, weighing about eight tons, which are just about to be hoisted from the truck and lowered into the pit. Larger sets of flues are handled easily. It requires from 2½ to 3 hours to clean them, unless they are very bad. The tank is 6 ft. 6 ins. deep and 20 ft. 6 ins. long. To keep the flues in position, shields or fenders are provided in the tank, which are adjustable for different lengths of flues. We are indebted to Mr. R. M. Crosby for the information and photographs. These machines are made by Joseph T. Ryerson & Son, Chicago.

100-TON STEEL HOPPER CAR

The Monongahela Connecting Railroad Company at Pittsburg has in service a number of cars which were built to carry 100 tons of ore at slow speeds. The bodies of these cars, when they were furnished, were quite similar to the body of a 100,000-lb. capacity car as ordinarily furnished by the car builders. They were designed to carry the lading evenly distributed and were intended to carry ore from the stock yards to the furnaces, about three-quarters of a mile. The cars gave very good service until it was decided, in order to facilitate the unloading, that the load should be concentrated over the hopper doors. Under these conditions there was found to be some deflection in the sides at the bottom edge and the top of the sides buckled, taking the form of a reverse curve. The angle at the top of the sides was 3½x3½x5/16 ins., and in order to strengthen the car a 5x5x½ in. angle was added. The first car to be strengthened in this manner was tested with increasing loads up to 272,500 lbs. of ore, which was carried from the stock yards to the furnaces, the car not showing any sign of weakness. Since that time all the other cars have been strengthened in this manner.





100-TON STEEL HOPPER CAR—MONONGAHELA CONNECTING RAILROAD COMPANY.

end of the train, where the brake-pipe pressure builds up rapidly, spring, 33, will be somewhat compressed by the piston when going to the release position, thus allowing the slide valve, 3, to pass beyond full release position and partly close the exhaust port. As the brake-pipe pressure equalizes throughout the train, and feeds through into the auxiliary reservoirs, the difference of pressures on the two sides of the piston becomes less, and the slide valve is gradually forced back to the full exhaust opening.

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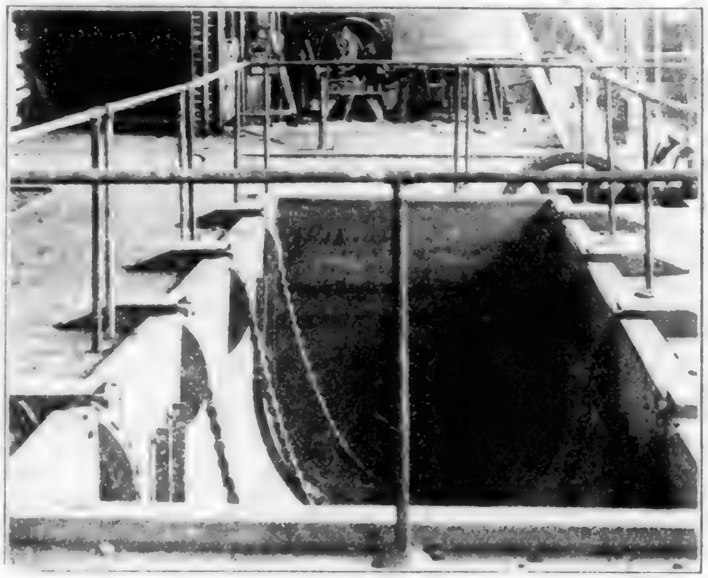
In all other respects the operation of this valve is practically that of the present F 36 or H 49 triple valves. Its outward appearance, when attached to the auxiliary reservoir, is so much like these valves that, to distinguish it, a thin lug is cast on the top of the body in a position easily seen from the side of the valve; and its designation "K-1" or "K-2" is also cast on the side of the body, the former replacing the F 36 and the latter the H 49 standard valves.

A large number of these valves are already in service, giving results that are in every way satisfactory. The serious problems brought forward by the rapidly changing conditions of freight service have made it absolutely necessary to increase the power and flexibility of the air brake. Yet the adoption of any new device would entail such an immense amount of expense and inconvenience, that the arrangement above outlined whereby the valves now in service can be utilized and transformed to give the required results with only a slight addition to the number of parts and with little expense, will prove to be one of the most important improvements yet brought out in connection with air-brake equipments.

NEW MACHINE FOR CLEANING FLUES.

A new machine for cleaning flues has recently been installed at the South Tacoma shops of the Northern Pacific Railway, which is similar in principle to those in use at the Topeka shops of the Atchison, Topeka & Santa Fe Railway and the Angus shops of the Canadian Pacific Railway, the construction and operation of which were fully described and illustrated on page 221 of the AMERICAN ENGINEER AND RAILROAD JOURNAL, June, 1904. The advantages of these machines are that they will clean a larger number of flues at one time and clean them quicker than by other methods. As the flues

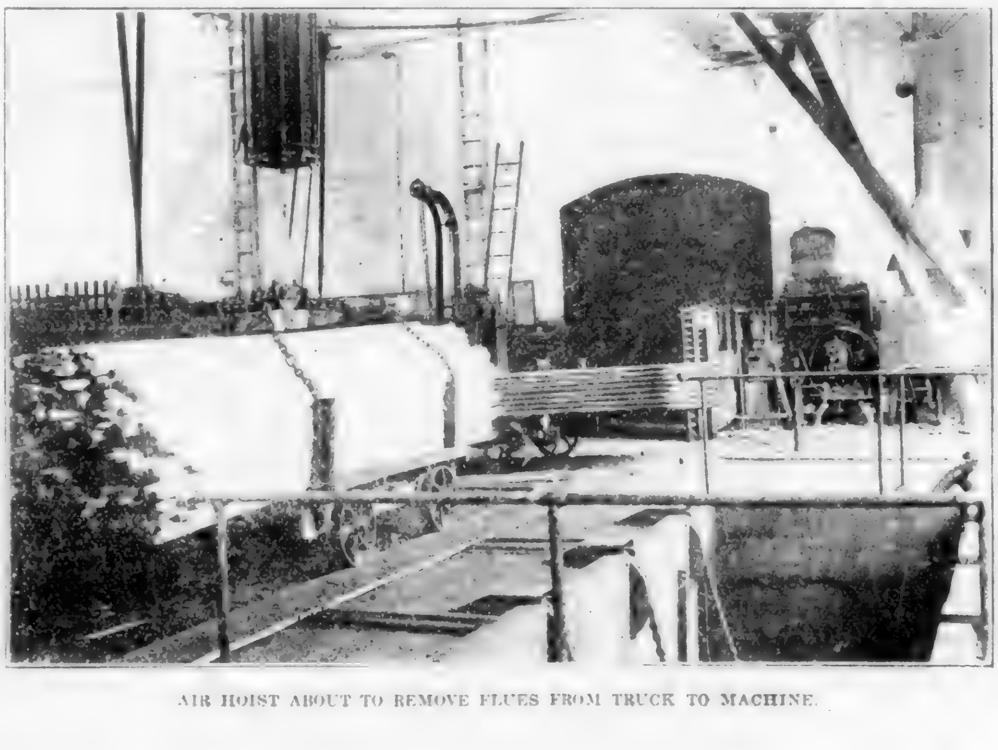


NEW MACHINE FOR CLEANING FLUES.

are rolled under water the noise is greatly reduced. The cost of handling the flues in and out of the machine is reduced to a minimum.

The overhead works have been done away with on the machine at South Tacoma, making it more compact and convenient. Instead of having only two sprocket chains, one of which is adjustable to suit the length of the flues, there are four sprocket wheels mounted on a shaft on each side of the tub, or tank, as shown in the illustration. These sprocket wheels are so placed that the chains will clear the sides and

COMPARATIVE SAFETY OF TRAVEL IN UNITED STATES AND ABROAD.—I have collected some data from other sources, and have, as far as possible, verified it. During the year ending June 30th, 1903, the total number of passengers killed on railroads operating in European countries was 536; in the United States these figures aggregated 321. The mileage of the European roads was 177,363, and in the United States 207,977 miles, so that for every 331 miles of road in Europe during this period you will note one passenger was killed, as against one passenger to each 648 miles in the United States, which suggests the conclusion that fatalities to passengers are not greater on American than on foreign railways. In point of fact, during the period mentioned, such fatalities seem to be at the ratio of 2 to 1 in favor of United States railways.—*Mr. W. G. Besler, New York Railroad Club.*



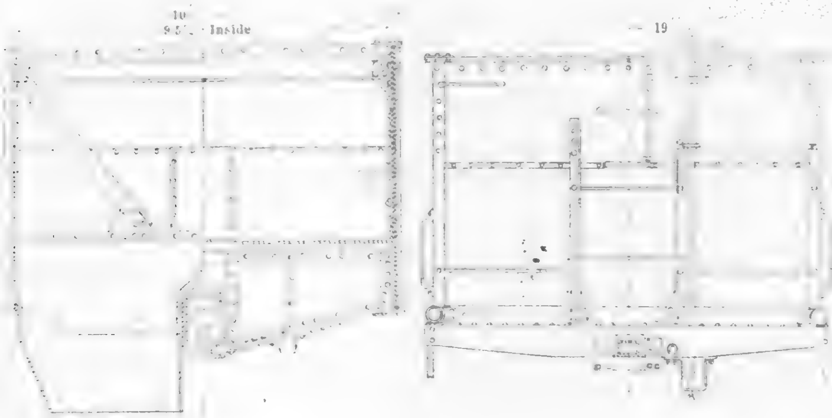
AIR HOIST ABOUT TO REMOVE FLUES FROM TRUCK TO MACHINE.

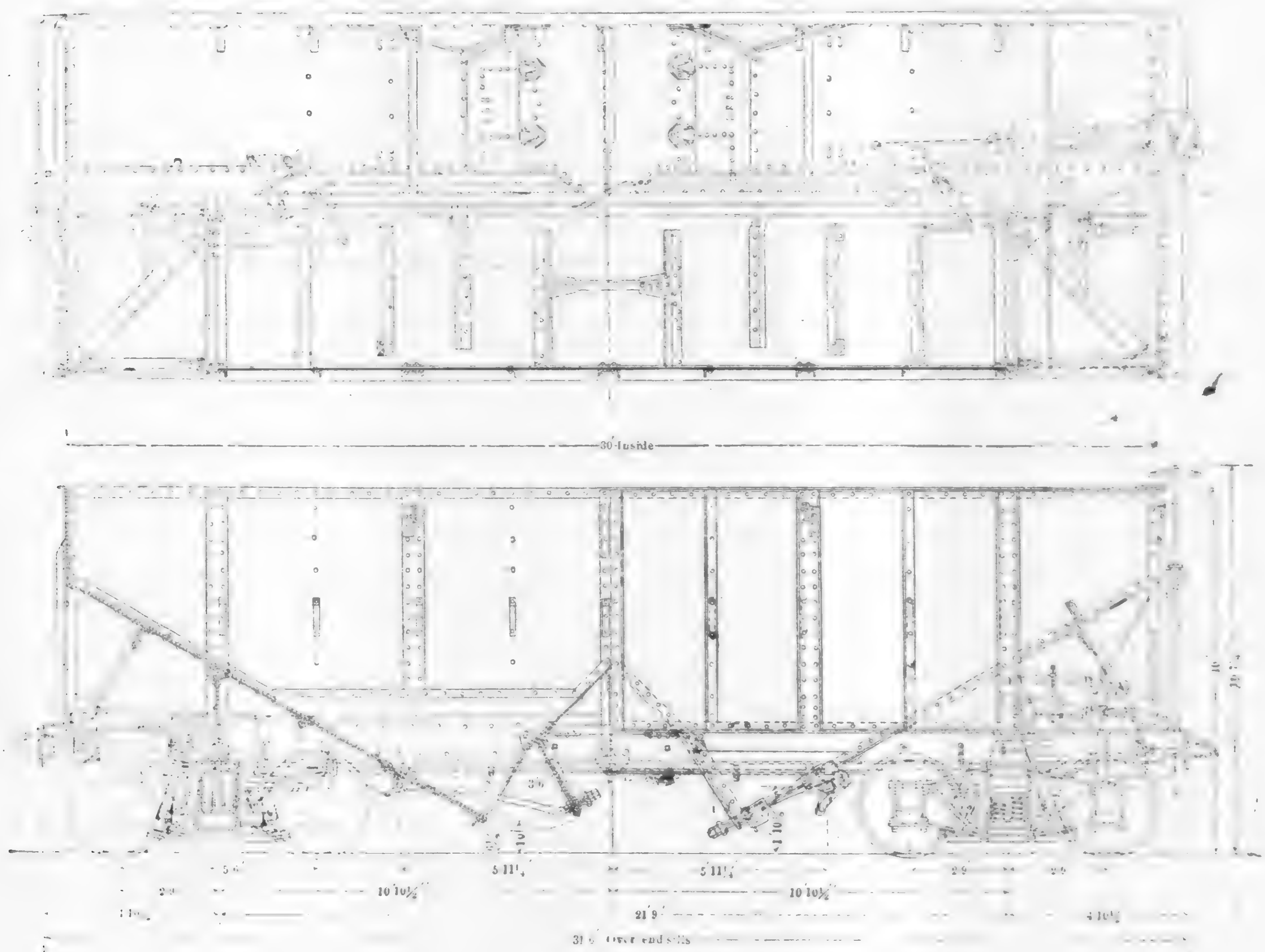
bottom of the tank by about 6 ins. The tops of the sprocket wheels are about level with the floor line. There are a number of idlers at the bottom of the tank, so situated that the brackets upon which they are mounted answer for the legs of the tank and allow about 1 in. clearance for the chain to pass under the bottom of the tank.

The flues are raised and lowered into the tank by means of an overhead trolley air hoist. The chains which handle the flues are allowed to remain in the tank during the process of cleaning, so that it is only necessary to attach the hoist to the chains when they are ready to be removed. One of the illustrations shows a truck load of 378 2-in. flues, weighing about eight tons, which are just about to be hoisted from the truck and lowered into the pit. Larger sets of flues are handled easily. It requires from 2½ to 3 hours to clean them, unless they are very bad. The tank is 6 ft. 6 ins. deep and 20 ft. 6 ins. long. To keep the flues in position, shields or fenders are provided in the tank, which are adjustable for different lengths of flues. We are indebted to Mr. R. M. Crosby for the information and photographs. These machines are made by Joseph T. Ryerson & Son, Chicago.

100-TON STEEL HOPPER CAR

The Monongahela Connecting Railroad Company at Pittsburg has in service a number of cars which were built to carry 100 tons of ore at slow speeds. The bodies of these cars, when they were furnished, were quite similar to the body of a 100,000-lb. capacity car as ordinarily furnished by the car builders. They were designed to carry the lading evenly distributed and were intended to carry ore from the stock yards to the furnaces, about three-quarters of a mile. The cars gave very good service until it was decided, in order to facilitate the unloading, that the load should be concentrated over the hopper doors. Under these conditions there was found to be some deflection in the sides at the bottom edge and the top of the sides buckled, taking the form of a reverse curve. The angle at the top of the sides was 3½x3½x5/16 ins., and in order to strengthen the car a 5x5x½ in. angle was added. The first car to be strengthened in this manner was tested with increasing loads up to 272,500 lbs. of ore, which was carried from the stock yards to the furnaces, the car not showing any sign of weakness. Since that time all the other cars have been strengthened in this manner.





100-TON STEEL HOPPER CAR—MONONGAHELA CONNECTING RAILROAD COMPANY.

The sides of the car are ¼ in. thick and the centre sills are 15-in. channels. The cars are equipped with Westinghouse friction draft gear. The axles have 5¾x10-in. journals. The body of the axle is of uniform diameter instead of being tapered in the middle, as is the usual custom. Although there have been several derailments of these cars, there has never been any failure on the part of the journals or axles. Cast-steel truck bolsters furnished by the American Steel Foundries are used. The cars were built by the Standard Steel Car Company. We are indebted to Mr. H. W. Watts, master car builder, for drawings and information.

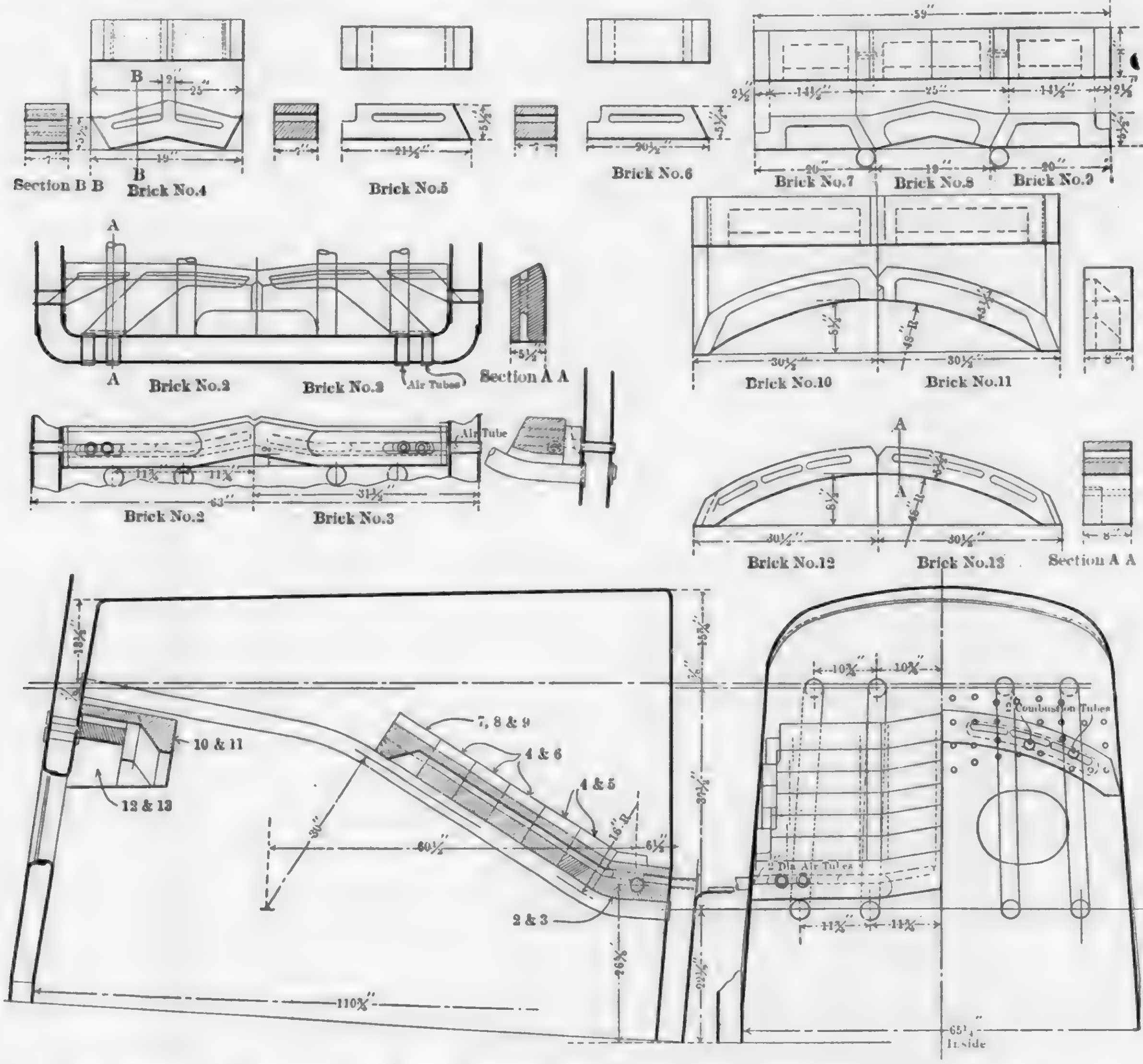
WADE-NICHOLSON HOLLOW BRICK ARCH.

Through the courtesy of Mr. Robert Quayle, superintendent of motive power of the Chicago and Northwestern Railway, drawings have been received illustrating the application of hollow fire brick arches on that road, the engravings presenting the arrangement employed in Atlantic type passenger locomotives.

The arch is built in two parts, the larger part being supported on the water tubes in the usual way and the smaller arch over the door is supported on studs. The large arch weighs approximately 929 lbs. and the smaller arch 310 lbs. The blocks of each arch are made hollow, having oval passage ways for air, receiving air from 2-in. tubes passing through the water spaces. The air becomes heated in its passage through the arches and is discharged, through openings directing the current, downward towards the fire. Fire clay is used to make the arches tight and to secure air-tight joints at the ends of the air tubes.

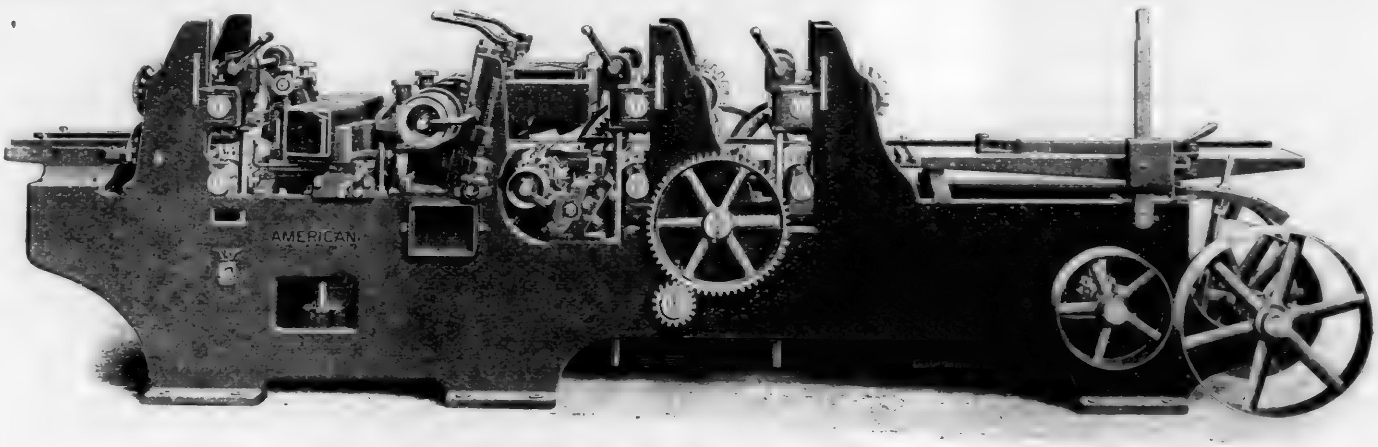
Mr. Quayle states that he has used about 200 of these arches, covering a period of eight months, and that he finds their life to be about three times that of the ordinary arch. He also states that it produces a practically smokeless condition while the locomotive is working, which means that proper combustion is taking place in the firebox and that unconsumed carbon does not pass out of the stack in the form of smoke. The result in economy has not yet been determined by tests, but on the Wisconsin division where the most thorough trials have been made the master mechanic reports considerable saving in fuel.

In order to get the best work out of the locomotive the firemen are obliged to fire lighter than they would without this arch, which constitutes a strong feature of this device, because heavy firing is not only the cause of black smoke but also produces dirty fires, clinkered grates and a consumption of more coal than is required with light firing. In order to get at the tubes the central portion of the large arch is removed, and when repairs are completed the central portion of the arch may be replaced without detriment to the arch. Mr. Quayle states that this arch does not cost more than the old arch and he finds decided advantages in it.



WADE-NICHOLSON HOLLOW FIRE BRICK APPLIED TO ATLANTIC TYPE LOCOMOTIVE—C. & N. W. RY.

Boiler Tube Diameter.—The ratio of diameter to length of the tube undoubtedly has a most important bearing upon the steaming qualities of the boiler and upon the efficiency of the heat absorption. This is more particularly noticeable when the boilers are being worked to the limit of their capacity.—*Mr. G. J. Churchward, before the Institution of Mechanical Engineers.*



NO. 131 AMERICAN SERIES PLANER AND MATCHER, WITH LOWER CYLINDER CUTTING FIRST.

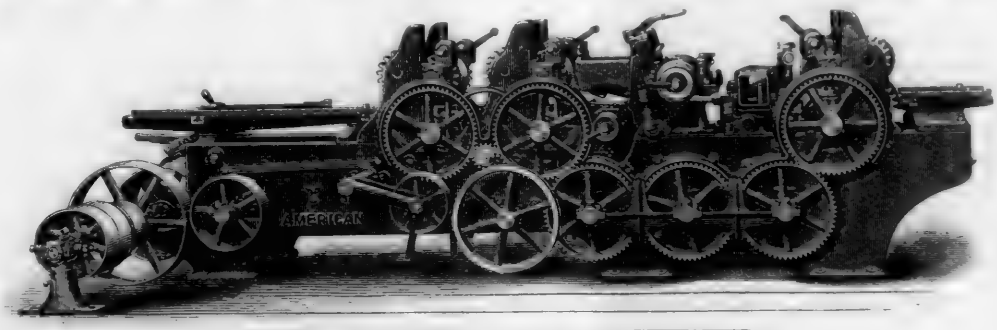
AMERICAN PLANER AND MATCHER.

The American planer and matcher, illustrated herewith, is a medium weight machine, with all of the essential features and adjustments that have proved of value in up-to-date planing mill practice. Special attention has been paid to make all parts easy of access, either for adjustment or repair, and the sides are so designed that it is convenient to get under the machine from either side. Special bolts, with only two sizes of heads, are used in all the working parts, so that it is possible to set up the machine and make all necessary adjustments with one wrench. These machines are built in two sizes, 9 and 15 ins. wide; they will surface from ⅜ in. to 6 ins. thick, and joint and match from 2 ins. to the full width of the machine.

The feed consists of six 9½-in. rolls, geared at both ends, fitted with a parallel lift, and having adjustable spring pressure, which gives a feed at any rate between 40 and 120 ft. per minute. The upper and lower heads are of hammered crucible steel and are interchangeable. They are slotted on all sides, have projecting chip breaking lips, and carry 4-in. knives with a cutting circle of 7½ ins. The journals, 2¼ ins. in diameter, running in self-oiling boxes that are yoked together both before and behind the cut, in connection with pneumatic pulleys with ample belt surface, effectually prevent undue friction and loss of power. Both the upper and lower heads have leveling devices for lining up with the bed of the machine. The upper head chip breaker and the upper and lower head pressure bars have a lateral adjustment, that permits the use of a knife that projects 1 in. beyond the lip of the head. Tool steel points that are easily adjusted or replaced in case of need are fitted in the upper chip breaker. The pressure bar at the rear of the upper head is rigid, but has a vertical adjustment while the machine is running.

The lower head is placed just in front of the upper head, giving a smooth surface on the under side of the stock to rest on the bed while the upper or finishing cut is taken. It pulls out by means of an accurately cut screw of coarse pitch for setting or sharpening of knives, and when replaced is securely locked in position by a hand lever. It may be adjusted vertically while the machine is running to bring the top of the cutting circle in exact line with the rear pressure bar. Two pressure shoes, with adjustable spring pressure, hold the stock while passing over the lower head, and are carried by the upper head yoke. The bar in front of the lower head and the two lower in-feeding rolls are so arranged that, by moving a lever at the front end of the machine, the cut of the lower head may be changed as desired while the machine is running, without altering the finished thickness of the stock or disturbing the cutter head, and any desired amount of stock may be removed up to ¼ in. If desired, the machine can be instantly adjusted for single surfacing without removing any of the belts.

The side head spindles are of crucible steel, 2 ins. in the bearings and 1 13/16 ins. where heads go on, ground true and run in self-oiling boxes; pneumatic pulleys effectually prevent slipping of belts. The lower end of the spindle rests on an adjustable bronze step immersed in oil. The side-head yokes are made in two parts; by loosening four bolts the part that holds the spindle may be taken out for rebabbitting without removing the screws, lock shafts or the part of the yoke that rests on the way. The side-head pressure feet are readily adjusted and locked while running. Both heads are quickly adjusted from the side of the machine by screws and are fitted with a device for taking up lost motion. Each head has an independent clamping device. The chip breakers for the side heads have tool-steel points that are easily replaced in case of wear. These machines, made by the American Woodworking Machinery Company, require from 10 to 15 h.p. for driving and weigh about 11,000 lbs.



VIEW SHOWING GEARED SIDE OF PLANER AND MATCHER.

Electric Driving of Machine Tools.—While the losses of power in transmission by shafting and belting are very generally represented by 50 per cent. of the output at the engine, the corresponding losses in the case of electric transmission from engine to tool are rarely more than 25 per cent. But it must be borne in mind that losses for mechanical transmission are constant and that those for electric transmission vary with the energy consumed. Hence the power required for electrically driven tools is usually much less than half that necessary for belt-driven tools. In addition to the saving of power, electric driving possesses the further advantage, that a greater output per machine is obtainable, owing to the flexibility of the method, and, further, its cleanliness and the non-obstructiveness to overhead cranes are features of much importance in many engineering workshops.—*Engineering Review.*

STEAM TURBINE TRAIN LIGHTING SET.

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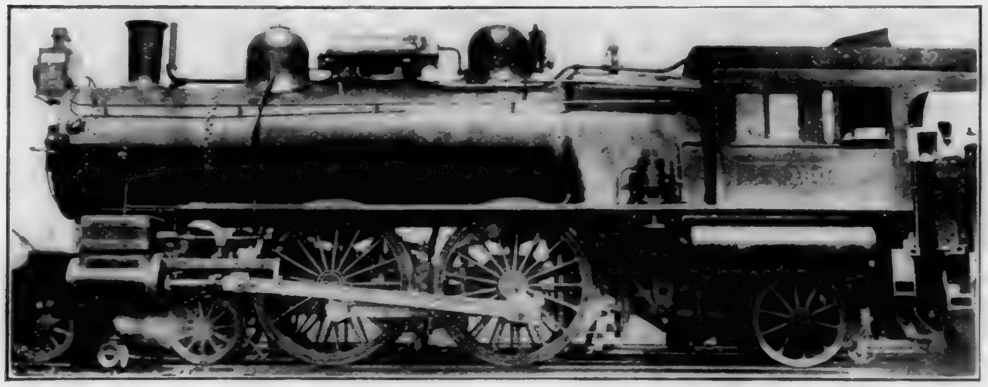
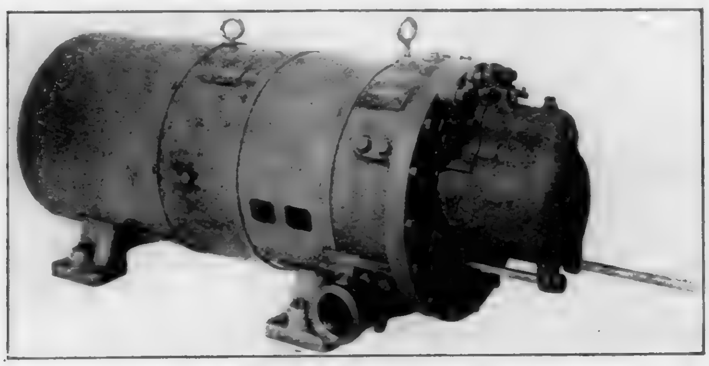


TURBINE TRAIN LIGHTING SET MOUNTED ON LOCOMOTIVE.

The usual methods of generating electricity for train lighting can be divided into three general classes: first the direct storage battery, which is fully charged before the car or train leaves the yards, is of sufficient capacity to furnish the lights in that one car or train for its whole run; second, generators installed on the truck and driven from the axle, which are supplemented by a storage battery for use when the car is not in motion, and third, the steam-driven generator located usually at the head end of the forward baggage car, steam being obtained from the locomotive through flexible connections. This system does not usually include a storage battery auxiliary, although such can be used if desired. Each of these systems have been developed, and it is possible to obtain efficient and satisfactory lighting by either of them, the choice being determined by the cost of installing and operating and the difficulty of operation and maintenance.

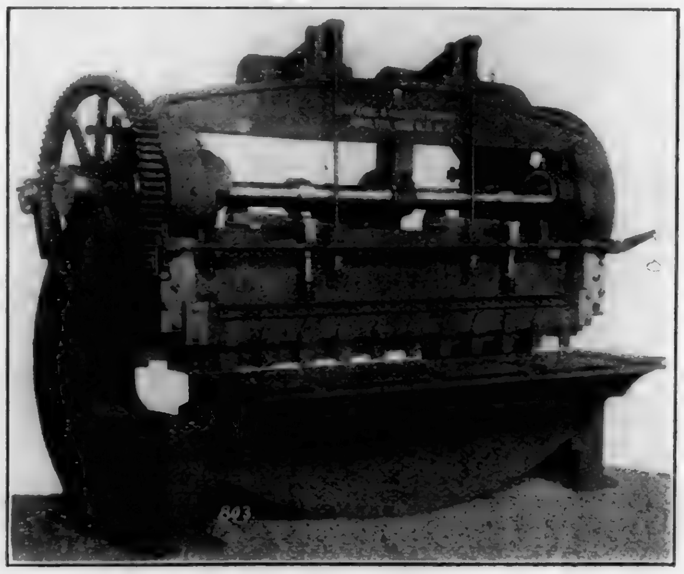


TURBINE TRAIN LIGHTING SET—GENERAL ELECTRIC CO.

There has recently been developed by the General Electric Company a new train lighting set, which consists of a generator directly coupled to a Curtis steam turbine, the two mounted on one base, and forming a very compact generating set. This set, which is illustrated herewith, is adapted for installation either in a baggage car, where it occupies a minimum amount of room and eliminates the vibration usual with the reciprocating engine set, or can be mounted directly upon the locomotive itself. The latter scheme has the advantage of doing away with any flexible steam connections, and permits the engineer to control the apparatus. One of the views herewith shown illustrates how this set appears mounted upon the locomotive boiler.

An apparatus of this nature is not unfamiliar to railroad men, as a similar generating set for electric head and cab lighting has been in quite general use. In this case a similar apparatus, but of size sufficient to furnish lights for the whole train as well as the locomotive is used. These sets are now to be obtained in three sizes, with generators of 15 k.w., 80 volts, 20 k.w., 125 volts, and 25 k.w., 125 volts. In each case the set consists of a suitable size single stage Curtis steam turbine direct connected to a two pole direct current generator. These generators, because of their high speed, the largest one running at 3,600 r.p.m. and the medium size at 4,500, are very small and compact for their capacity. The complete set for the smallest size weighs but 1,850 lbs.

The turbine is constructed to operate at steam pressures of from 80 to 200 lbs., and exhaust directly into the atmosphere. The speed is controlled by a centrifugal tension spring governor operating a balance poppet valve, and will carry its full rated load until the steam pressure drops below 75 per cent. of the normal pressure. Liberal bearing surface is provided, the journals between the generating and turbines on the 25-k.w. set being 3 by 13 ins. and the end journals being 1½ by 6 ins. The bearings are lubricated by pressure oil, there being a pump geared to the generator end of the shaft and giving about 5 lbs. of oil pressure. Oil rings are also provided. On the two smaller size sets lubrication is obtained from oil rings alone. The voltage of the generator is regulated by a field rheostat, the electrical instruments being placed in the cab when the set is mounted on the locomotive. The 25-k.w. set will supply about 430 sixteen-candle power lights, including the locomotive headlight. The machine can be run with the headlight alone when the engine is disconnected, in which case the car lights are usually supplied by a small storage battery.



MOTOR DRIVER GATE SHEAR.

These generating sets are now in operation on several of the principal railroads in the country, and are reported to be operating satisfactorily.

HEAVY MOTOR-DRIVEN GATE SHEAR

The accompanying illustration shows a new motor-driven gate shear with a 20-in. throat, made by the Long & Allstatter Company, Hamilton, Ohio, and designed to cut sheets 100 in. long by ⅜ in. thick. It is provided with automatic hold-down clamps which securely hold the sheet while it is being sheared, and with an automatic stop which brings the slide to rest at the completion of each stroke, with the blades open ready for the next cut. The motor is mounted on a bracket on the rear

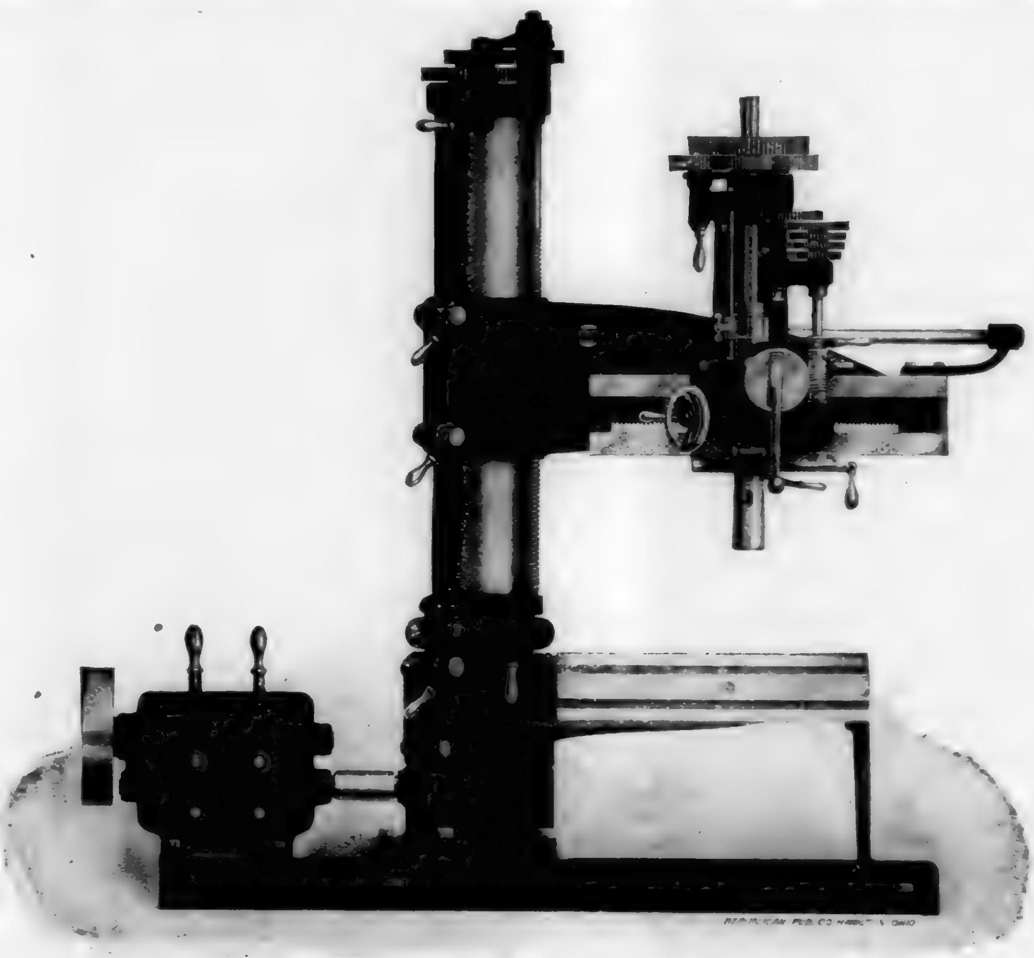
of one of the housings. The cam shaft is of forged steel and has a centre bearing, as shown. The table, to which the lower blade is attached, is adjustable.

3½ FOOT RADIAL DRILL.

The American 3½-ft. plain radial drill, illustrated herewith, has been specially designed to meet the heavy duty imposed by the use of high-speed twist drills. The speed box, which provides four changes of speed, each being instantly available by the use of the two levers shown, is of the geared friction type. The frictions are of very simple and strong design and very powerful. The speed box can readily be removed and replaced by a cone, if so desired. Where a motor drive is used, the builders recommend that it be connected to the speed box through gearing.

The column is of the double tubular type. A sleeve or outer column revolves about an inner column which extends nearly to the top of the outer column, thus making a very rigid construction. The arm is of a parabolic beam and tube section, making it very effective for resisting both bending and torsional strains. The lower line of the arm is parallel with the base of the machine, thus permitting work to be operated upon close to the column. The arm is raised and lowered rapidly by a double-thread coarse pitch screw which is controlled by a lever conveniently placed. The head is moved along the arm by a hand wheel through an angular rack and spiral rack pinion. It can quickly be locked into position by a conveniently placed clamping lever. Back gears are located on the head. The spindle has eight changes of speed ranging from 37 to 295 revolutions per minute, all available without stopping the machine.

The feed mechanism provides four changes, ranging from .0069 to .0203 in. per revolution. The feeds can be automatically tripped at any position of the spindle by an adjustable trip dog and pointer acting on the worm clutch. This trip acts automatically at the full depth of the spindle, thus preventing breakage of the feed mechanism. The tapping mechanism is carried on the head between the back gears and the speed box, thus giving to the frictions the benefit of the back gear ratio, making unusually heavy tapping operations possible and also permitting the taps to be backed out at high speed. The box table has a top surface of 16 by 32 ins. and a side surface 6 by 32 ins. The greatest distance from the spindle to the base is 4 ft. 3 ins.; the spindle traverses 10 ins. and the head traverses 2 ft. 10¾ ins. on the arm. No wrenches are required with this tool. It is made in three sizes, with 2½, 3 and 3½ ft. arms, by the American Tool Works Company, Cincinnati, Ohio.



AMERICAN 3½-FT. ARM PLAIN RADIAL DRILL.

RAILROAD Y. M. C. A.—Ten years ago the railroad companies paid 60 per cent. of the cost of the R. R. Y. M. C. A. while the men paid 40 per cent; this last year the companies paid 40 per cent. and the men 60.—*Central Railway Club.*

TIDE COMPUTING MACHINE.—The Coast Survey at Washington, D. C., has an intricate machine, invented by Prof. William Ferrel, which cost about $3,500, and accurately predicts the time of high or low tide for a given locality. The machine takes into account 19 different elements which affect the tide and does the work of 40 expert computers. A new machine is now being built, which will take into account 39 elements which affect the tide, and will operate automatically, making predictions for as long a time as desired.

FORGING AND MACHINING LOCOMOTIVE FRAMES.—Hammered or forged iron may cost 3c. per lb., while the scrap turnings or borings will not net over ½c. per lb. If the frame forge men will work carefully and keep the stock on a main frame within ¼ in. all over, they will do their work as well as could be expected; but for every additional 1-16 in. there will be a dead loss of $3 to $4. Thus it is not always a question of how cheaply you can plane frames, but how you can best forge them.—*Mr. C. J. Crowley, Western Railway Club.*

COMMERCIAL ENGINEER.—In a characteristic address at the annual smoker of the Railway Club of Pittsburgh, Mr. Geo. A. Post argued that the man who sells things is entitled to a degree, and suggested that he be called a "commercial engineer." The members of the club were so pleased that they have had an abstract of the address attractively printed on large sheets of paper suitable for framing. If it is in order, we would suggest that some one "start the ball rolling" by conferring a "master's" degree upon Mr. Post. He deserves it.

THE MECHANICAL INDEX.—The Donnell-Colvin Company, 256 Broadway, New York, have purchased *The Mechanical Index* from the publishers of *Machinery*. The "Index" will contain the names of all manufacturers of mechanical tools and appliances. Both of the above gentlemen are specially well fitted for the work, and they promise that the results of their efforts will soon be apparent.

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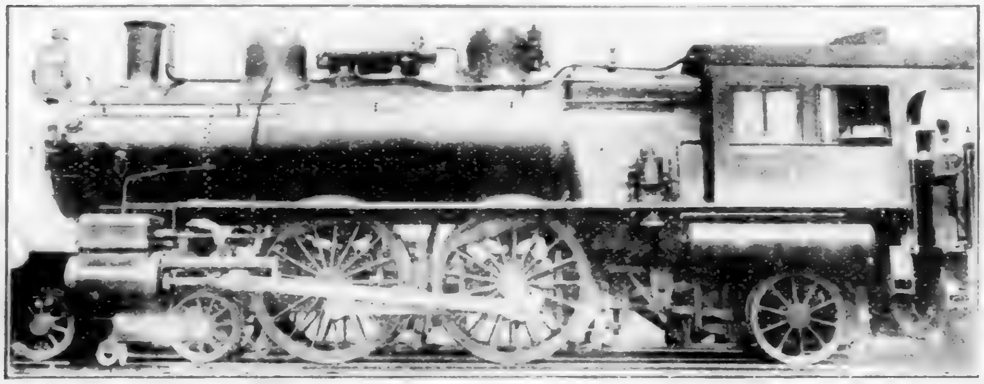

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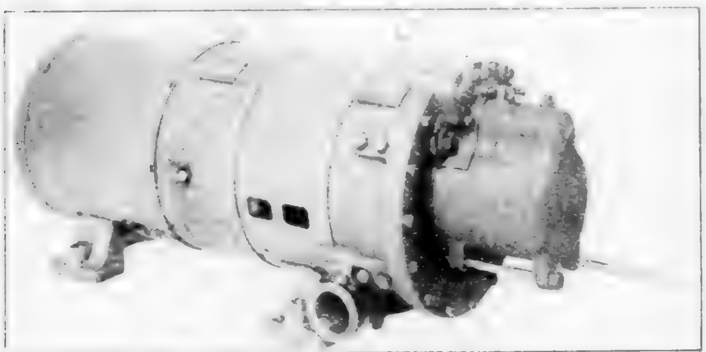

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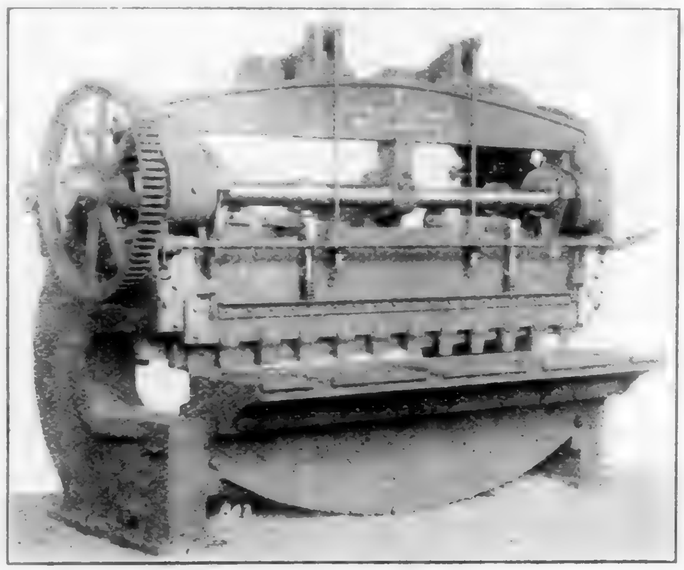

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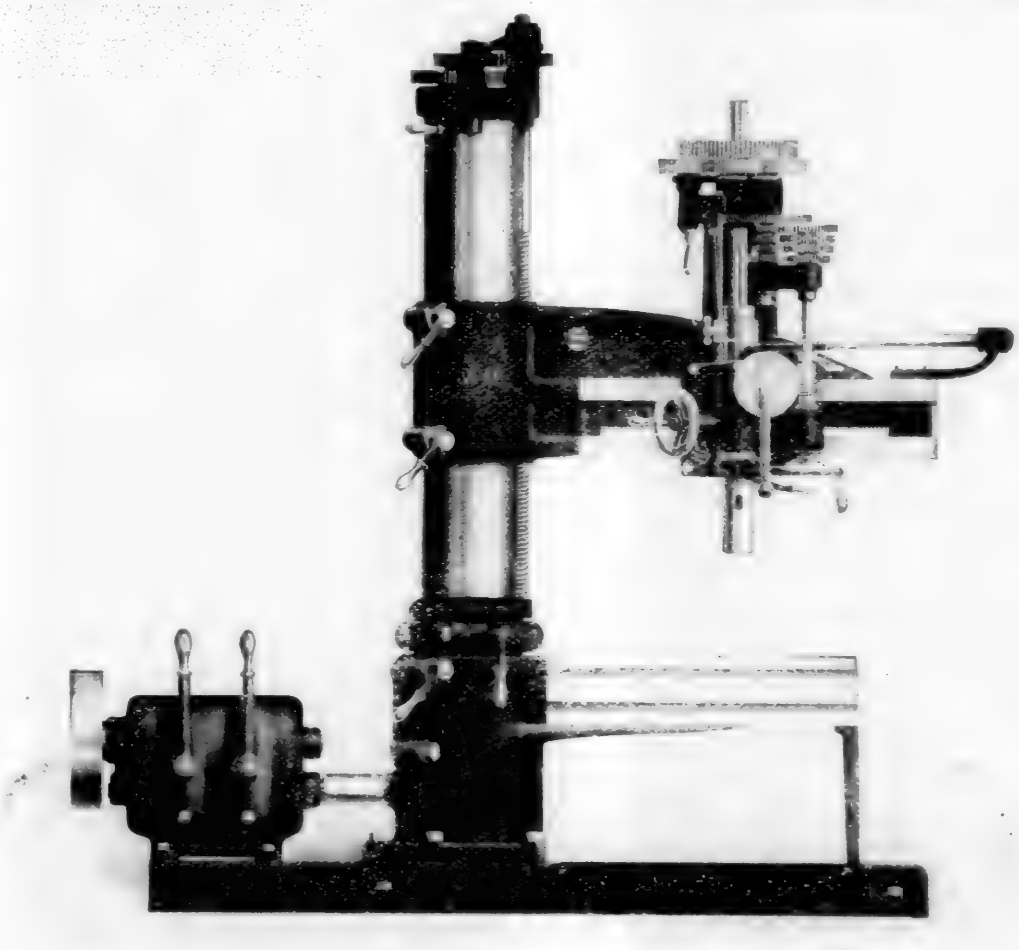
The American 3½-ft. plain radial drill, illustrated herewith, has been specially designed to meet the heavy duty imposed by the use of high-speed twist drills. The speed box, which provides four changes of speed, each being instantly available by the use of the two levers shown, is of the geared friction type. The frictions are of very simple and strong design and very powerful. The speed box can readily be removed and replaced by a cone, if so desired. Where a motor drive is used, the builders recommend that it be connected to the speed box through gearing.

The column is of the double tubular type. A sleeve or outer column revolves about an inner column which extends nearly to the top of the outer column, thus making a very rigid construction. The arm is of a parabolic beam and tube section, making it very effective for resisting both bending and torsional strains. The lower line of the arm is parallel with the base of the machine, thus permitting work to be operated upon close to the column. The arm is raised and lowered rapidly by a double-thread coarse pitch screw which is controlled by a lever conveniently placed. The head is moved along the arm by a hand wheel through an angular rack and spiral rack pinion. It can quickly be locked into position by a conveniently placed clamping lever. Back gears are located on the head. The spindle has eight changes of speed ranging from 37 to 295 revolutions per minute, all available without stopping the machine.

The feed mechanism provides four changes, ranging from .0069 to .0203 in. per revolution. The feeds can be automatically tripped at any position of the spindle by an adjustable trip dog and pointer acting on the worm clutch. This trip acts automatically at the full depth of the spindle, thus preventing breakage of the feed mechanism. The tapping mechanism is carried on the head between the back gears and the speed box, thus giving to the frictions the benefit of the back gear ratio, making unusually heavy tapping operations possible and also permitting the taps to be backed out at high speed. The box table has a top surface of 16 by 32 ins. and a side surface 6 by 32 ins. The greatest distance from the spindle to the base is 4 ft. 3 ins.; the spindle traverses 10 ins. and the head traverses 2 ft. 10¾ ins. on the arm. No wrenches are required with this tool. It is made in three sizes, with 2½, 3 and 3½ ft. arms, by the American Tool Works Company, Cincinnati, Ohio.



AMERICAN 3½-FT. ARM PLAIN RADIAL DRILL.

Railroad Y. M. C. A.—Ten years ago the railroad companies paid 60 per cent. of the cost of the R. R. Y. M. C. A. while the men paid 40 per cent; this last year the companies paid 40 per cent. and the men 60.—*Central Railway Club.*

Tide Computing Machine.—The Coast Survey at Washington, D. C., has an intricate machine, invented by Prof. William Ferrel, which cost about $3,500, and accurately predicts the time of high or low tide for a given locality. The machine takes into account 19 different elements which affect the tide and does the work of 40 expert computers. A new machine is now being built, which will take into account 39 elements which affect the tide, and will operate automatically, making predictions for as long a time as desired.

Forging and Machining Locomotive Frames.—Hammered or forged iron may cost 3c. per lb., while the scrap turnings or borings will not net over ½c. per lb. If the frame forge men will work carefully and keep the stock on a main frame within ¼ in. all over, they will do their work as well as could be expected; but for every additional 1-16 in. there will be a dead loss of $3 to $4. Thus it is not always a question of how cheaply you can plane frames, but how you can best forge them.—*Mr. C. J. Crowley, Western Railway Club.*

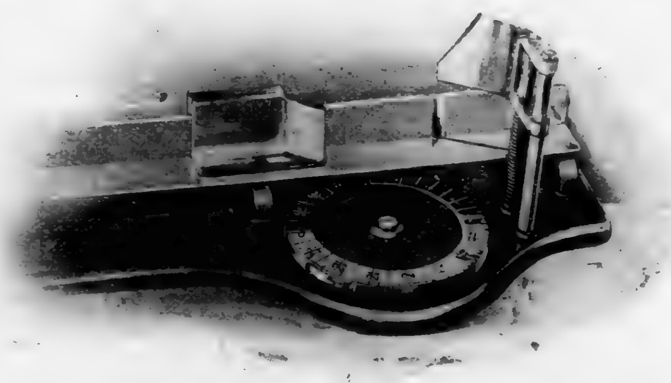
Commercial Engineer.—In a characteristic address at the annual smoker of the Railway Club of Pittsburgh, Mr. Geo. A Post argued that the man who sells things is entitled to a degree, and suggested that he be called a "commercial engineer." The members of the club were so pleased that they have had an abstract of the address attractively printed on large sheets of paper suitable for framing. If it is in order, we would suggest that some one "start the ball rolling" by conferring a "master's" degree upon Mr. Post. He deserves it.

The Mechanical Index.—The Donnell-Colvin Company, 256 Broadway, New York, have purchased *The Mechanical Index* from the publishers of *Machinery*. The "Index" will contain the names of all manufacturers of mechanical tools and appliances. Both of the above gentlemen are specially well fitted for the work, and they promise that the results of their efforts will soon be apparent.

EXACTO PACKING GAUGE AND CUTTER.

The difficulty of cutting continuous length packing so that it will exactly fit the rod or stem to be packed is well understood by those who have to perform this operation. Recognizing this trouble, Greene Tweed & Co., New York, have recently perfected a device which will easily and quickly perform this operation, so that the packing will exactly fit the rod, and that without any waste. The illustrations herewith give a clear idea of the appearance and general operation of this instrument. It will be seen that it consists of a guide for the packing which has an adjustable stop operated by means of a dial. At one end of the guide is a knife guide, which is held in place by a spring, the cutting being done by a serrated edge knife fitting into this guide.

In operating the instrument the dial is set at a figure which represents the diameter of the rod to be packed plus the thickness of the packing to be used. One end of the packing is then cut off at the bevel by the knife and is then pushed along the guide until it rests against the stop, when the knife guide is pressed down to hold the packing secure and the section is cut off. This can be duplicated for as many rings as are needed, each of which will be of exactly the same length, and will fit the rod exactly if the dial is properly set. The illustrations clearly show the different features of the instrument and method of operation.



HEATING ONE-STORY BUILDINGS.—"So far as their construction is concerned, the simplest of all structures requiring ventilation and heating are one-story biuldings, such as mills and shops. But no other form of building has so large an amount of wall and roof surface per cubic foot of enclosed space, or such high and extended rooms; in fact, such a building, as a rule, forms only a single room. As a consequence the most efficient system is necessary; it is not alone sufficient that the apparatus shall be large, to allow for the excessive heat loss from the building, but, above all, the arrangement of the distributing ducts must be such as to most economically utilize the heat supplied; for underheating at the floor and overheating above is one of the most natural consequences of an imperfect system of distribution. Under such circumstances the apparatus itself is frequently condemned as having insufficient capacity, when the trouble lies entirely in the manner in which the heated air is delivered to the building.

"In buildings of this type the principal provision is to be made for the heating, for the occupants are generally separated and the air supplied for heating will answer all the requirements of ventilation. But it is, nevertheless, necessary that they should be provided with fresh air in sufficient quantity. One of the inherent virtues of this method of heating is that it ensures such supply. As the air provided is generally in excess of that required for ventilation, increased economy can be secured by using over again a portion of the previously heated air. This may be done by arranging dampers or doors so that part of the air entering the heater is drawn from out of doors and part, or, if desirable, the whole from the room. In fact, in the ordinary manufactory the common practice is to nominally take the entire air supply from within the building. This does not result, as might be supposed, in a total lack of ventilation, for a very considerable amount of outward leakage takes place through the walls and around windows and doors. Sufficient, indeed, to cause a similar inward, but imperceptible, leakage at other points in such quantity as to result in a comparatively frequent change of air within the building.

"One of the greatest difficulties in a building of this character is to heat it rapidly in the morning, after it has cooled during the night. No other system can so completely and rapidly meet this requirement as that here presented. When it is desirable, the engine may be run slowly all night, and the building maintained at a moderate temperature. The exhaust from the engine being used in the heater, no expense is entailed for motive power."—*Extract from Treatise on Ventilation and Heating published by B. F. Sturtevant Company.*

FLAT AND CURVED CROWN-SHEETS.—The gradual extension of the practice of making the top of the firebox and casing flat instead of round is noticeable. On the Great Western Railway less trouble has been experienced with the flat-top firebox than with the round top, although no slingstays of any kind are used. The flat top has the important advantage of increasing the area of the water line at the hottest part of the boiler, and so materially contributes to the reduction of foaming. This, combined with the coned connection to the barrel, has enabled the dome, always a source of weakness, to be entirely dispensed with and drier steam obtained. The author some years ago made an experiment to settle this much-disputed point. Two identical engines and boilers were taken, one boiler having a dome in the usual position on the barrel, the other having no dome, the steam being taken by a pipe from the top of the flat firebox casing. The engine without the dome proved to be decidedly freer from priming than the other. The liberal dimension of 2 ft. between the top of the firebox and the inside of the casing no doubt contributed to this satisfactory result.—*Mr. G. J. Churchward, before the Institution of Mechanical Engineers.*

DOUBLE TAPERED DIES.

The illustration shows the double taper used in all Armstrong dies. As will be seen, the threads at the entrance of the die are given a greater taper than the standard. This forms a natural and easy lead for the dies, allowing them to start on the pipe with the least possible pressure and without the use of the lead-screw. By reason of this double taper it

DOUBLE TAPERED DIES.

is not necessary to file off the swelling or burr often formed by the cutting tool on the end of a piece of pipe. The advantages of the double taper may be illustrated by the fact that it is an easy matter for one man alone to start the thread on a 2-in. or even larger pipe without resorting to the lead-screw. These dies are made by The Armstrong Manufacturing Company, Bridgeport, Conn.

Improved Passenger Traffic Conditions.—The following figures, with reference to railways in the United States, should prove interesting, in comparison with conditions ten years ago, namely, 1894: Railroad mileage in 1903 increased 16 4/10% over 1894; passengers carried in 1903 increased 28½% over 1894; passengers carried one mile in 1903 increased 46 3/10% over 1894; passengers killed in 1903 increased 9½% over 1894. From the above it will be noted that while the number of passengers carried increased during the past ten years 28½%, the number of fatalities to passengers increased but 9½%.—*Mr. W. G. Besler, New York Railroad Club.*

PERSONALS.

Mr. W. McAllister, master mechanic of the Pennsylvania Railroad at Camden, N. J., has been retired under the pension rules of the company.

Mr. J. J. Cavanaugh has been appointed master mechanic of the San Luis Division of the Mexican Central Railway, vice Mr. Thos. Smith, resigned.

Mr. H. W. Johnson has been appointed master mechanic of the Brookfield Division of the Chicago, Burlington & Quincy Railway, succceeeding Mr. A. N. Willsie.

Mr. H. G. Huber has been appointed assistant master mechanic of the Pennsylvania Railroad at Verona, Pa., to succeed Mr. Taber Hamilton, transferred.

Mr. B. E. McNierney has been appointed master mechanic of the Tacoma Eastern R. R. with offices at Bismarck, Wash., to succeed Mr. H. F. Weatherby, resigned.

Mr. D. A. Ross has been appointed road foreman of engines for the Beaumont Division of the Gulf, Colorado & Santa Fe Railway, vice J. J. Wagner, resigned.

Mr. A. S. Williamson has been appointed mechanical inspector of the Mexican Central Railway, with office at Aguascalientes, Mexico.

Mr. M. E. Wells, who was recently appointed traveling master mechanic of the Wheeling & Lake Erie Railroad, has been appointed assistant master mechanic with office at Columbia, Ohio.

Mr. M. J. McCarthy, who was recently appointed master mechanic of the Lake Shore & Michigan Southern Ry. at Elkhart, Ind., will also have jurisdiction over the Indiana, Illinois & Iowa.

Mr. Austin J. Collett has been appointed electrical engineer of the Union Pacific Railroad, under the superintendent of motive power and machinery, with headquarters at Omaha, Nebraska.

Mr. A. C. Hinckley, heretofore master mechanic of the Cincinnati, Hamilton & Dayton Railway, has been appointed superintendent of motive power, including the car department, with headquarters at Lima, Ohio.

Mr. Peter Harvie, superintendent of shops of the Great Northern Railway at Havre, Mont., has been transferred to Everett, Wash., in a similar capacity. He has been succeeded at Havre by Mr. K. A. Froberg.

Mr. C. H. Andrus, heretofore general foreman of the West Philadelphia shops of the Pennsylvania Railroad, has been appointed general locomotive inspector of that company, and will have his headquarters at Altoona, Pa.

Mr. G. W. Seidel has resigned as master mechanic of the Chicago, Rock Island & Pacific Railway, at Horton, Kansas, and has been succeeded by Mr. W. L. Harrison, who has been transferred from Cedar Rapids, Iowa.

Mr. C. H. Burk has been appointed assistant superintendent of machinery of the Mexican Central Railway, with headquarters at Aguascalientes, Mexico. Mr. R. H. Rutherford has been appointed master mechanic, Chihuahua Division, vice Mr. C. H. Burk.

Mr. James Coleman has been appointed master car builder of the Central Vermont Railway, with office at St. Albans, Vt. Mr. A. Buchanan, heretofore superintendent of the motive power and car departments, will hereafter devote his entire time to the motive power department.

Mr. A. W. Wheatley has been appointed assistant superintendent of motive power of the Union Pacific Railroad, with headquarters at Omaha, Neb. Mr. Wheatley recently resigned as superintendent of the East Moline shops of the Chicago, Rock Island & Pacific Railway.

Mr. Edward Eldon, general locomotive inspector of the New York Central & Hudson River, has been appointed master mechanic at East Buffalo, N. Y., to succceed Mr. Willliam Smith, who has been granted an extended leave of absence on account of ill health.

Mr. A. Forsyth, heretofore master mechanic of the Chicago, Burlington & Quincy Ry., at Aurora, has been appointed superintendent of shops at the same point. Mr. A. N. Willsie has been appointed master mechanic of the Aurora Division and Mr. P. J. Murrin, assistant master mechanic of the same division, has been assigned to other duties.

Mr. H. M. Meason, assistant master mechanic Pittsburgh Division, Pennsylvania Railroad, has been appointed general shop foreman on the Philadelphia Division; he is succeeded by Mr. C. J. Halliwell, engine-house foreman at Youngwood, who is in turn succeeded by Mr. J. W. Oschea, engine-house foreman at Conemaugh, Pa.

Mr. J. N. Mowery has been appointed mechanical engineer of the Lehigh Valley Railroad, instead of Mr. J. N. Mallory, as stated in our last issue.

BOOKS.

Link Motions, Valves and Valve Setting. By Fred H. Colvin. 82 pages. 4 by 6. Flexible cover. Published by the Derry-Collard Company, 256 Broadway, New York. Price 50c.

This is a modern treatise on the valve motions of the present day as operating both slide and piston valves. It is thoroughly illustrated and clearly written. It describes the different valve motions as applied to locomotives; carefully explains the proper method of setting and gives comprehensive rules and explanatory notes for setting. The Walschaert and other motions comparatively new to American practice are described.

CATALOGS.

IN WRITING FOR THESE, PLEASE MENTION THIS PAPER.

The McEwen Engine.—Bulletin No.17, from the Ridgeway Dynamo & Engine Company, Ridgeway, Pa., presents a detailed illustrated description of the various features of these engines.

Power Punching and Shearing Machinery.—A small and well-illustrated pamphlet from the Long & Allstatter Company, Hamilton, Ohio, describes their different lines of punching and shearing machinery.

Rope Driving.—The George V. Cresson Company, Philadelphia, have issued an interesting pamphlet on the subject of rope transmission. Its advantages are considered, the different systems of rope drive are described and several pages of valuable data are presented.

Centrifugal Sprinkling Car.—An attractive pamphlet from the J. G. Brill Company, Philadelphia, Pa., describes their centrifugal sprinkling car, which is adapted for street railroads and is radically different from the ordinary type of sprinkler. It is giving very satisfactory results on several roads on which it is used.

Rotary Converters for Railway Service.—Bulletin No. 4433, from the General Electric Company, describes the construction of their rotary converters for railway service. This company has built 842 rotary converters for railway work alone, not including those used in lighting plants, the aggregate capacity of which amounts to 384,030 k. w.

Reinforced Concrete.—A 160 page 5 by 8 in. catalog, from the Trussed Concrete Steel Company, Detroit, Mich., is devoted to a description of the Kahn trussed bar, records of several tests of the Kahn system of reinforced concrete and a number of illustrations of its application, notable among which is the roundhouse of the Grand Trunk Railroad at New Toronto, Ontario, Canada.

Link Motion.—H. B. Underwood & Company, of Philadelphia, are sending out to the master mechanics and superintendents of motive power of the various railroads copies of the treatise on "Link Motion," by Mr. Fred. H. Colvin, which is noticed under "Books" on this page. An appendix has been added describing and illustrating the several tools made by the above company for use in locomotive repair shops.

Air Brakes for Electric Cars.—The Westinghouse Companies' publishing department has reprinted an article on "Air Brakes For Electric Cars," which was presented by Mr. W. S. Bartholomew before the November, 1905, meeting of the New England Street Railway Association. The paper considers the advantages of this type of brake and describes the various types made by the Westinghouse Company.

Pintsch Gas Appliances.—A handsome 190 page standard 8¼ by 10¼ in. catalog, from the Safety Car Heating & Lighting Company, 160 Broadway, New York, illustrates and describes the various appliances used in connection with Pintsch gas. Several pages are devoted to hints on the selectiton of equipment. A sixteen page catalog, of the same size, describes the incandescent mantle lamps for Pintsch gas. With these mantles the candle power of Pintsch gas is increased more than three-fold and a satisfactory white light in produced.

Westinghouse Type SA Motors.—These motors and the controllers used in connection with them are described in circular No. 1117 issued by the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa. This new line of motors permits a speed range of 4 to 1 on a single voltage and is specially adapted for use in connection with machine tools. A complete description of these motors will be found on page 113 of our March issue.

NOTES.

Steam Turbines.—During the month of January, 1906, the Westinghouse Machine Company, East Pittsburg, Pa., entered orders for 22 steam turbines aggregating 56,500 brake horsepower in rated capacity, or an average of over 2,500 b.h.p. per turbine.

A Large Roofing Order.—In rebuilding the factories of the Ohio Brass Company, Mansfield, Ohio, which were partially destroyed by fire last year, the order for roofing was placed with the H. W. Johns-Manville Company through their Cleveland branch. The roofing to be used is the well-known "J-M Asbestos Roofing," which is coming into very general use for large manufacturing establishments, railroad depots and large buildings. The order, which amounted to 850 squares, was placed with this company only after a most thorough investigation of the various prepared roofings now on the market.

Quincy, Manchester, Sargent Company.—This company has been incorporated and will take over the business heretofore operated by the Railway Appliances Company. This includes the business and plant of the Railway Appliances Company at Chicago Heights, Ill., formerly owned by the Q. and C. Company, also the business and plant of the Pedrick & Ayer Company, of Plainfield, N. J., manufacturers of locomotive repair tools, electric and pneumatic hoists, cranes, and pneumatic riveters. The Quincy, Manchester, Sargent Company will also act as the sole selling agent for the product of the Elastic Nut & Bolt Company of Milwaukee, Wis.

Chicago Pneumatic Tool Company.—This company has closed its Norfolk office and will in the near future open an office in Richmond, Va. The Pittsburgh office will, on April 1st, be moved to 10 Wood Street, at which point a store building has been secured for the purpose of making a general display of air compressors and pneumatic tools, a stock of which will be carried at this point as soon as the factories are in a position to furnish it. An up to date repair department will also be maintained at this point. The Seattle, Wash., office has been closed and a new office has been opened at 184 6th Street, North, Portland, Oregon.

The Babcock & Wilcox Company Trade Mark.—A decree has been entered in the case of The Babcock & Wilcox Company against the Aultman & Taylor Machinery Company for infringement of trade mark in the United States Circuit Court for the Eastern Division of the Northern District of Ohio, in favor of The Babcock & Wilcox Company, in which the trade mark of The Babcock & Wilcox Company is sustained as good and valid. It consists of the word "Steam," accompanied by a representation of the type of engine known as the "Aeolipile of Hero," which consists in part of a sphere. The Aultman & Taylor Machinery Company are enjoined and restrained from directly or indirectly using, printing, publishing or putting into practice, or in any way counterfeiting or imitating said trade mark, or any like or similar thereto.

Standard Roller Bearing Company.—The capital of the Standard Roller Bearing Company of Philadelphia, has been increased from $2,000,000 to $3,500,000. This increase is required to provide for an enlargement in their factory and equipment. A four story factory, 150 by 200 feet, will be erected immediately for the manufacture of annular ball bearings, on which this company holds basic patents. During the past year they have equipped with machinery a four story building, 95 by 200 feet, and have also built and equipped an iron foundry, 70 by 150 feet, two stories in height; a hardening and tempering building, 70 by 150 feet, and a crucible steel castings plant, 60 by 100 feet. With the new building the company will employ over 1000 hands, in the manufacture of steel balls, ball bearings, roller bearings, automobile axles and annular ball bearings.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL

MAY, 1906.

STANDARDIZING LOCOMOTIVE EQUIPMENT.

CANADIAN PACIFIC RAILWAY.

II.

As was stated in the last number, the standard locomotive parts recently adopted by the Canadian Pacific Railway cover broadly but three types—the consolidation, ten-wheel and Pacific types as typified by classes M4, D10 and G1. Classes D11 and G2, which closely follow classes D10 and G1, were also included in the table, showing the broad field covered by the standards.

Of the consolidation locomotives included in the equipment of the road, class M4 contains 41 engines and is divided into four sub-classes, which differ from each other in boiler arrangement, due to the use of different types of superheaters and on account of some of the engines having driving tires fitted with retaining rings for hill service. Classes M4a and M4c include 21 engines fitted with the Schmidt fire tube type of superheater, having 88—1¼-in. superheating tubes 12 ft. 11½ ins. long, giving a surface of 375 sq. ft., and classes M4b and M4d have the Cole fire tube type of superheater, comprising 55—1¾-in. tubes 13 ft. 6 ins. long, giving a surface of 340 sq. ft. All of these were built during the latter part of 1904; the M4d (20 engines) at Schenectady and the others at Kingston and Montreal. They are all 180 per cent. engines.

The next older locomotives of the consolidation type are 42 of class M3, which are 155 per cent. engines. They are two-cylinder compounds of the Schenectady design, delivered in 1900. None of these are fitted with superheaters, but they were given considerable attention in the designing of the standards and a large percentage of the standard parts are used on them.

Class M4, which may be considered to be the standard consolidation locomotive, is a 21 by 28-in. simple engine, having 57-in. drivers and weighing 186,200 lbs., of which 163,700 lbs., or 87½ per cent., is on drivers. The tractive effort of 36,800 lbs. bears a ratio of 4.45 to the tractive weight. The boiler is of the extended wagon top type 69 ins. in diameter at the front ring and carries a pressure of 200 lbs. The number of tubes, and hence the tube heating surface, vary in the different sub-classes according to the type of superheater used. Of those engines using the Schmidt boiler tube type there are 22—5-in. tubes and 244—2-in. tubes, which gives a tube heating surface of 2,216 sq. ft., and with a firebox heating surface of 165 sq. ft., common to all sub-classes, gives a total heating surface of 2,281 sq. ft. In those engines using the Cole type of superheater there are 55—3-in. tubes and 255—2-in. tubes, giving a tube heating surface of 2,705 sq. ft. and a total heating surface of 2,870 sq. ft. The engines shown in the table of dimensions herewith are the ones using the Schmidt type, and hence the ones having the smaller heating surface but a somewhat larger superheating surface. The tubes in all cases are 14 ft. 1⅜ ins. long.

The firebox measures 65¼ by 96⅝ ins. at the mud ring, giving a grate area of 43 sq. ft. The grate slopes forward in two sections. The outside firebox sheet is vertical and the inner sheet, which is 4½ ins. from it at the mud ring, inclines inward, giving a water space of 6½ ins. at the point where the curve of the crown sheet begins. The mud ring is 5 ins. wide in front and 3½ ins. wide at the back. The water space at the back increases to 4¼ ins. at the crown sheet. The crown sheet is 3 ins. higher at the front end than at the back and is radial stayed. The front flue sheet is set into the forward barrel sheet a distance of about 14 ins., which gives a front end nearly 70 ins. long, the stack being set 30 ins. ahead of the flue sheet. This space is required for the installation of the superheaters.

An order of 20 of this class, which are now under construction, are to have the steam pressure reduced to 175 lbs. and the cylinders increased to 22½ by 28 ins., which will give the same power as 21 by 28-in. cylinders with 200 lbs. pressure. They are to be equipped with the C. P. R. superheater, the economy of which it is believed will offset the greater cylinder volume and the reduction in boiler troubles due to the lower pressure will be clear gain. This will be the first example in this country of obtaining a saving from the use of superheated steam through this channel.

The illustrations show the rational design of this boiler very clearly, and cross-sections are given showing the location of tubes when used with either design of superheater. Some of the special fittings which are of interest will be considered later.

The cylinders, frames, wheels and other standard parts of this locomotive will be illustrated and described in a later article.

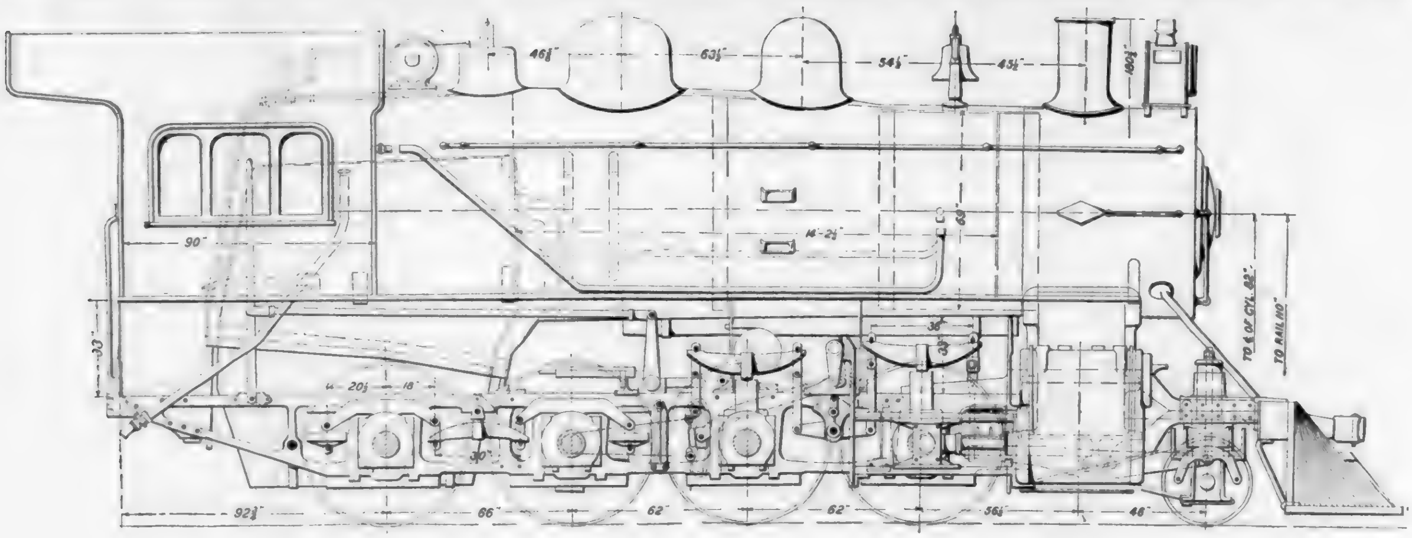
The 10-wheel standard type, class D10, includes 95 engines to which may be added 5 wide firebox culm burners, class D11, that are similar with the exception of the boiler, back frames, etc.

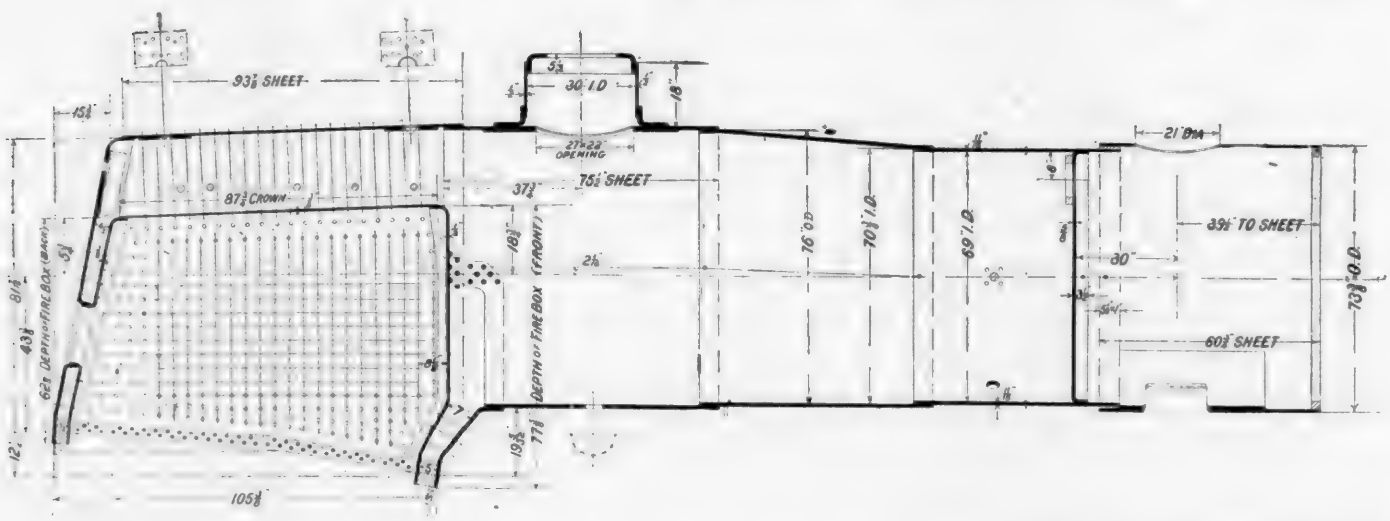
Class D9 contains 38 155 per cent. two-cylinder compound locomotives, which use more standard parts than any other single class not considered as a standard engine. Thirty-seven of this class are Schenectady compounds having cylinders 23 and 35 by 30 ins., 63-in. drivers and 200 lbs. boiler pressure. They weigh 190,000 lbs., with nearly 142,000 lbs. on drivers, and have 378—2-in. tubes, giving a heating surface of 2,885 sq. ft. and a total heating surface of 3,065 sq. ft. One of this class is equipped with the Schmidt fire tube type of superheater.

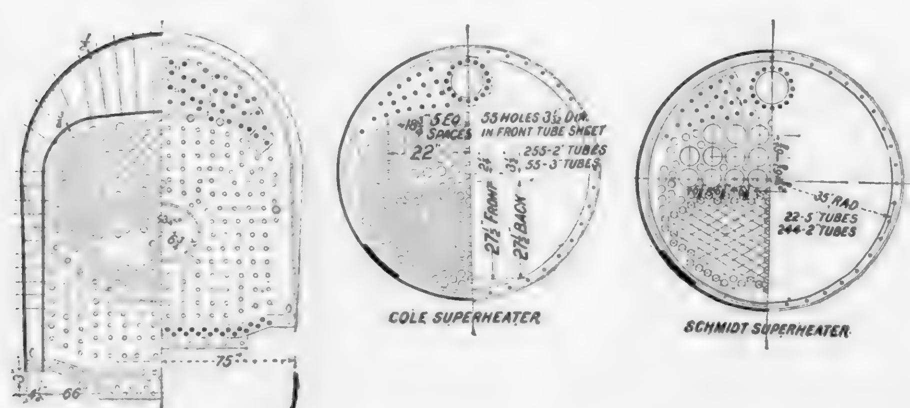
Classes D10 and D11 are 21 by 28-in. piston valve engines, with 63-in. drivers. Class D10 weighs 190,000 lbs. total, of which 141,000 lbs. is on drivers. It is divided into three subclasses, because of the different types of superheaters used. Ten of the engines have Schmidt superheaters with 88—1¼-in. superheating tubes having an average length of 13 ft. 1 in. and giving a superheating surface of 378 sq. ft.; 55 are equipped with the Cole superheater, also having 88—1¼-in. superheating tubes 12 ft. 8 ins. long, giving a heating surface of 370 sq. ft., and the remaining 30 engines have the C. P. R. superheater, having the same number of tubes and the same surface as the Cole. In all cases the tube heating surface in the boiler is 2,233 sq. ft. and that in the firebox 180 sq. ft., giving a total of 2,013 sq. ft. The grate area of 49 sq. ft. gives 49.2 sq. ft. of heating surface per square foot of grate.

Class D11, the boiler for which is illustrated herewith, has somewhat shorter flues than the D10, being 13 ft. 7⅛ ins., as compared to 14 ft. 2⅞ ins., and has a much larger grate area. As can be seen, the firebox is very shallow and the grate is level. A single door opening of exceptional width has been used. In order to allow firing so wide a grate from a single door this opening was made 40½ ins. wide. This class is also equipped with a C. P. R. superheater, having 88—1¼-in. tubes with an average length of 10 ft. 8 ins., giving a superheating surface of 307 sq. ft. The shorter flues reduce the total heating surface as compared with D10 and give a total of 2,313 sq. ft., of which 188 is in the firebox and 2,125 in the tubes. The illustrations shows the general arrangement of this boiler, which differs from that used on the class D10 principally in the firebox. Some of the boiler details will be taken up later.

The general elevation of the class D10, illustrated herewith, shows the general dimensions and location of the different parts, and later on in this article the details will be taken up and separately discussed. The class D11 differs in general arrangement from D10 in the fact that the very wide firebox made it necessary to place the cab on the boiler shell. This changed the location of the sand box and bell, the former



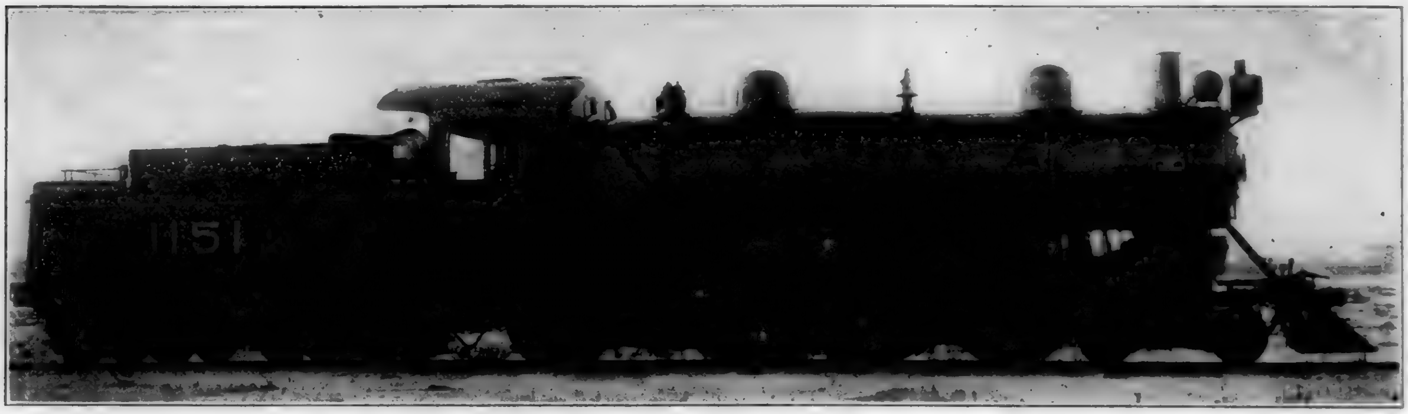


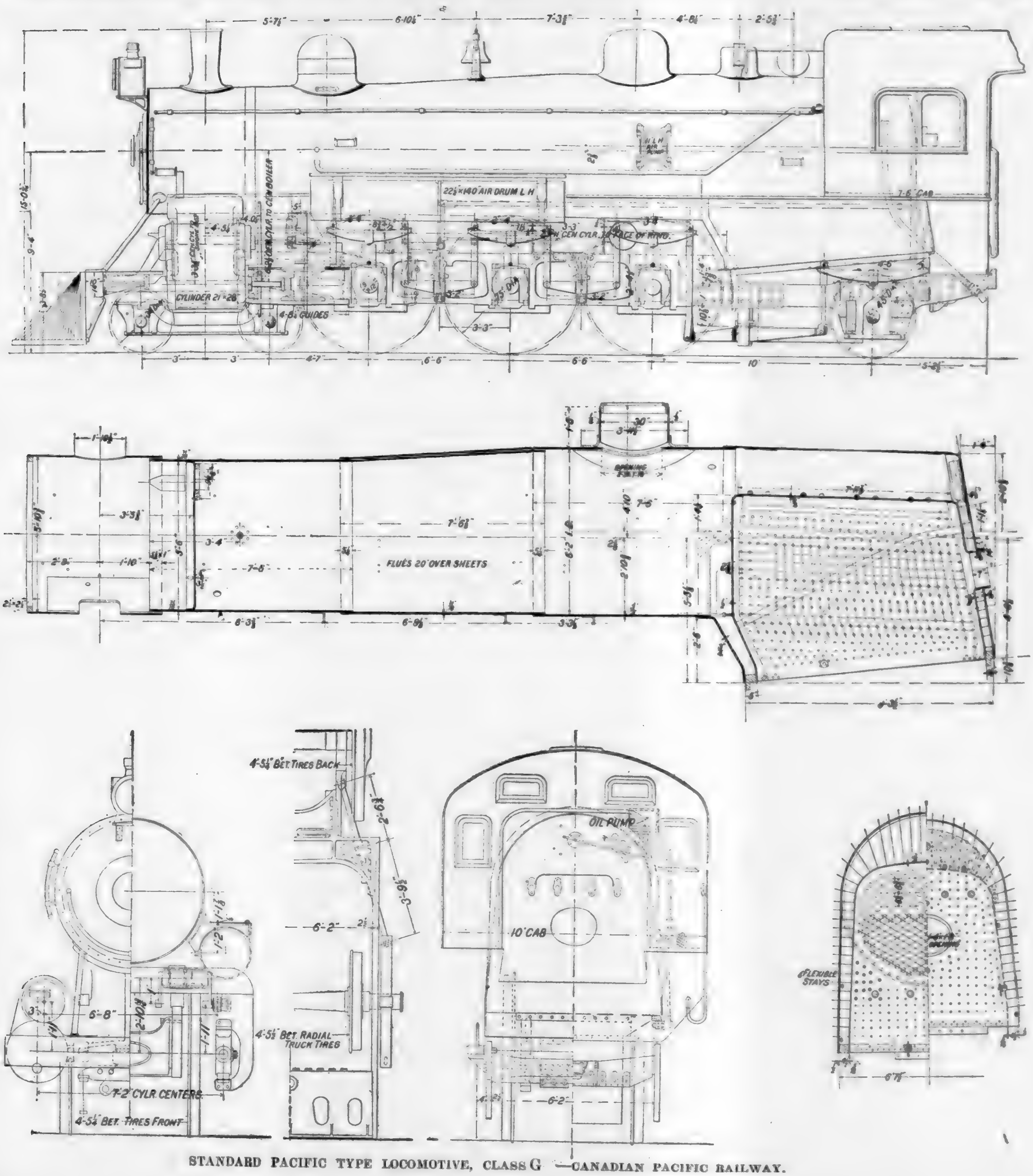


STANDARD CONSOLIDATION LOCOMOTIVE, CLASS M4.—CANADIAN PACIFIC RAILWAY.

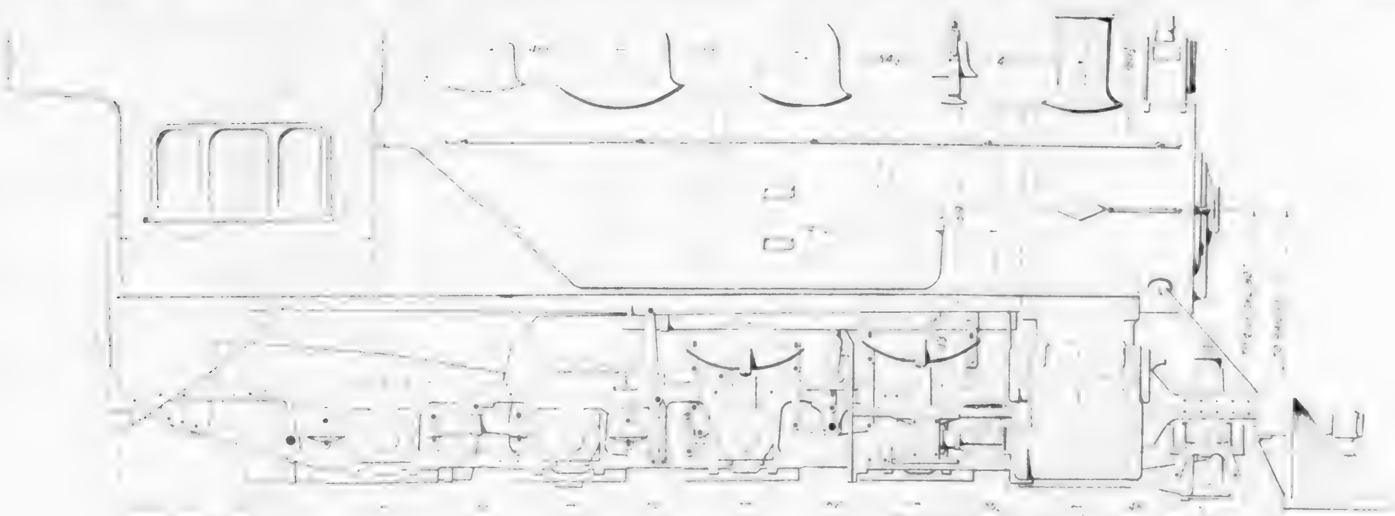
being placed on the front barrel sheet and the latter above the firebox. A fireman's cab, which is of standard design except for length, is placed at the rear of the firebox. This location of the cab made some rearrangement of the location of the air drums, air pump, etc., necessary.

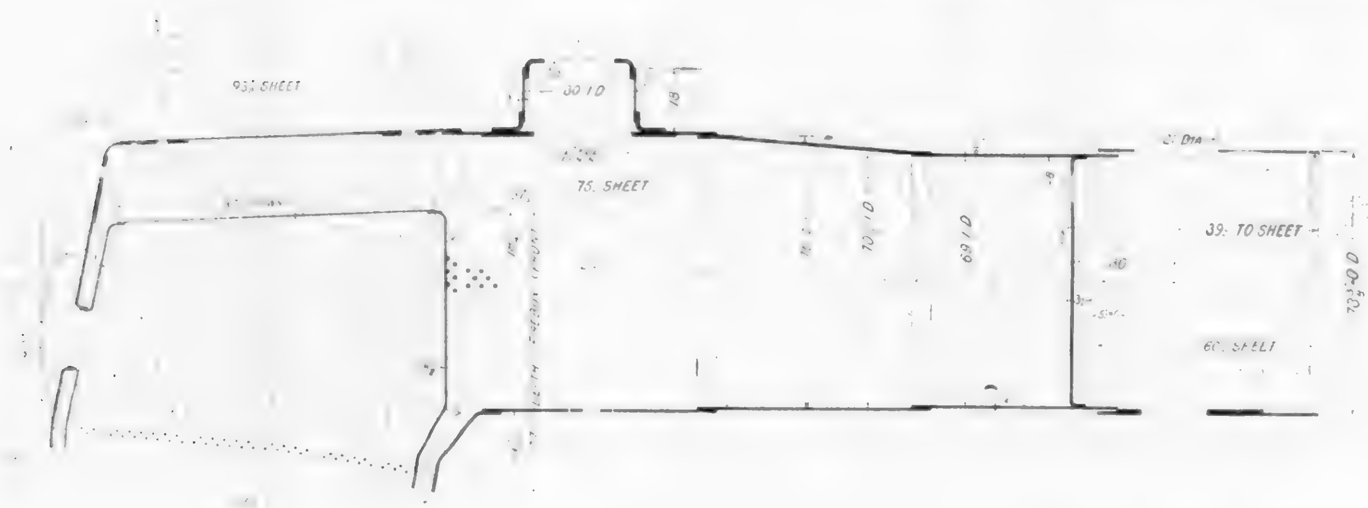
The Pacific type locomotives on this road are all included in the classes G1 and G2, which differ from each other principally in the size of the driving-wheels, the former having 75-in. wheels and the latter 69-in., and in the length of tubes, the former being 19 ft. 6 ins. long and the latter 20 ft. long. These classes are the first to be designed complete,

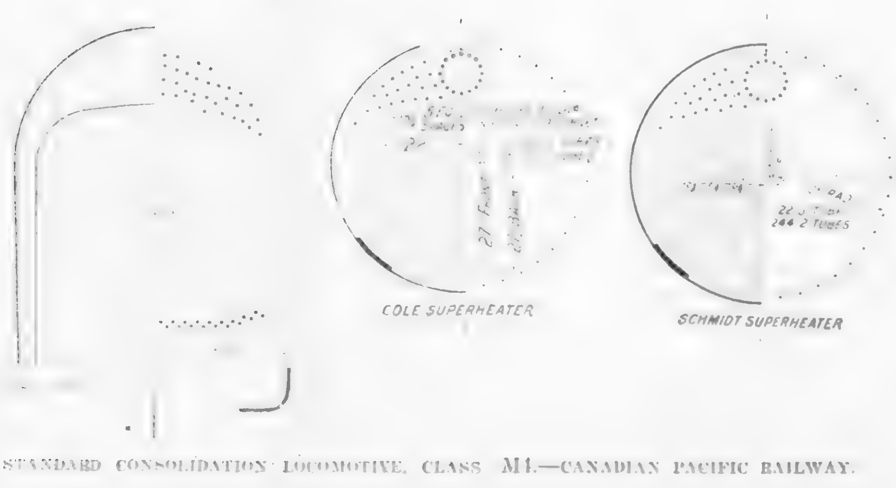




STANDARD PACIFIC TYPE LOCOMOTIVE, CLASS G —CANADIAN PACIFIC RAILWAY.



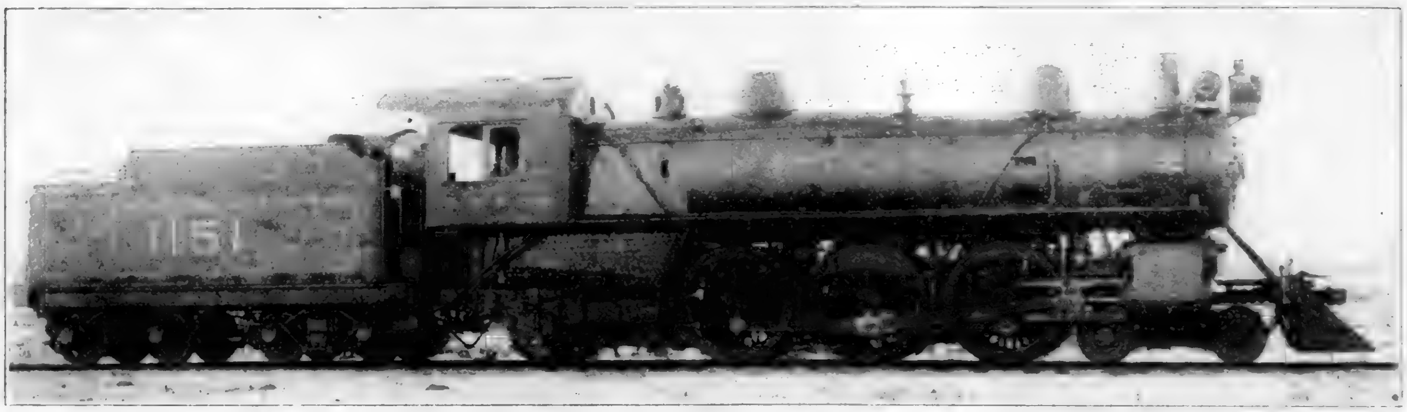


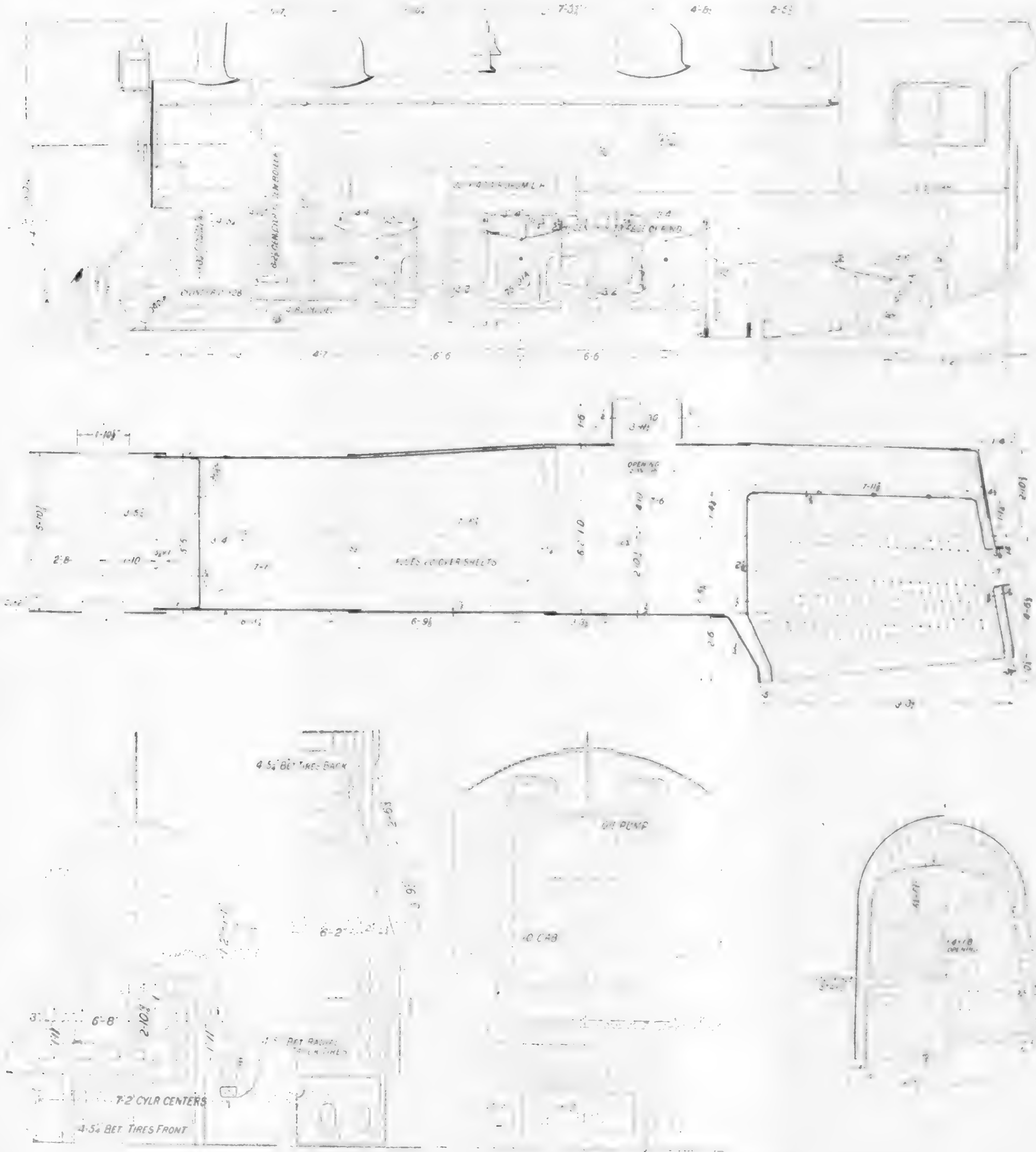


STANDARD CONSOLIDATION LOCOMOTIVE, CLASS M4.—CANADIAN PACIFIC RAILWAY.

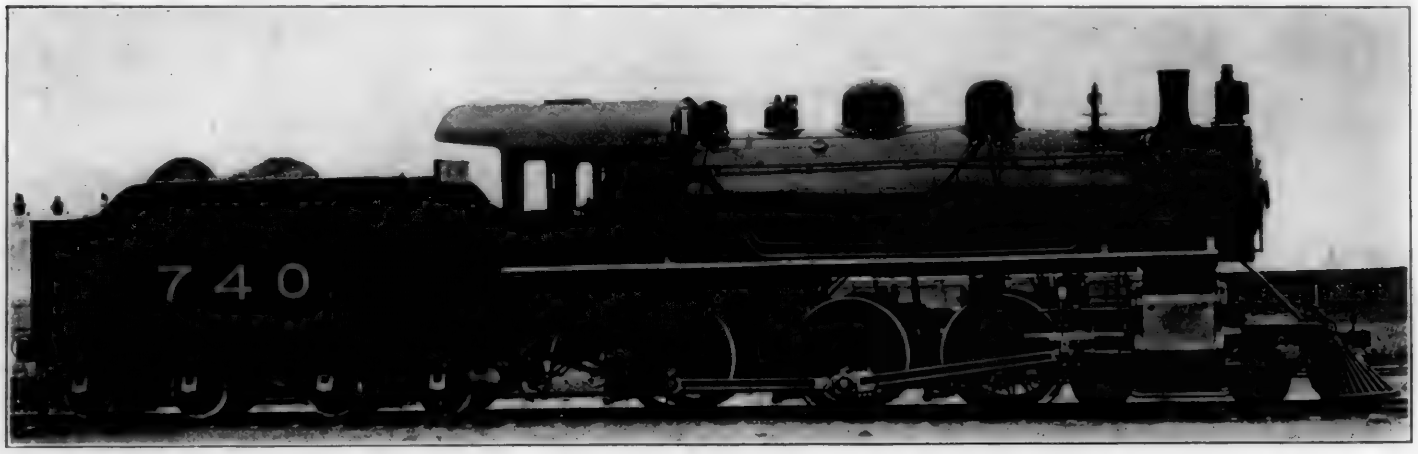
being placed on the front barrel sheet and the latter above the firebox. A fireman's cab, which is of standard design except for length, is placed at the rear of the firebox. This location of the cab made some rearrangement of the location of the air drums, air pump, etc., necessary.

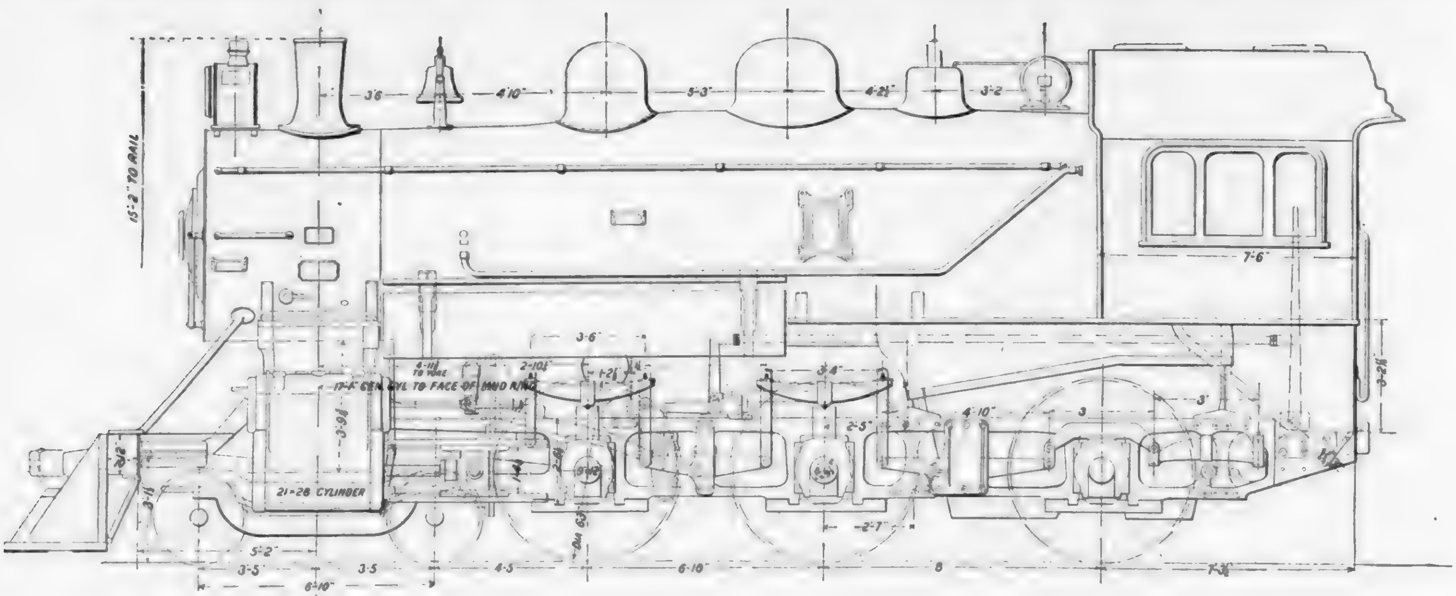
The Pacific type locomotives on this road are all included in the classes G1 and G2, which differ from each other principally in the size of the driving-wheels, the former having 75-in. wheels and the latter 69-in., and in the length of tubes, the former being 19 ft. 6 ins. long and the latter 20 ft. long. These classes are the first to be designed complete,

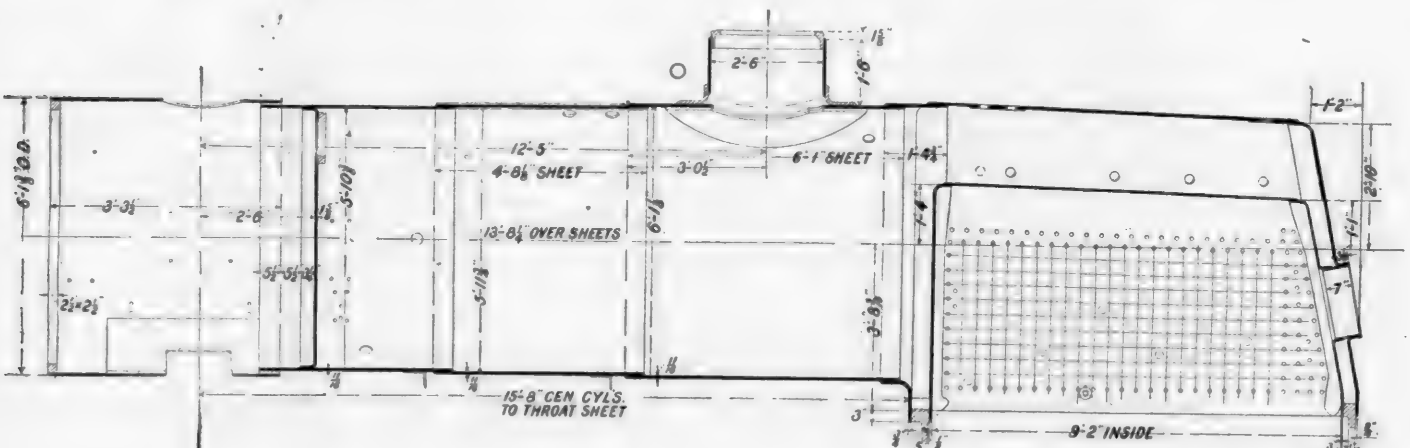


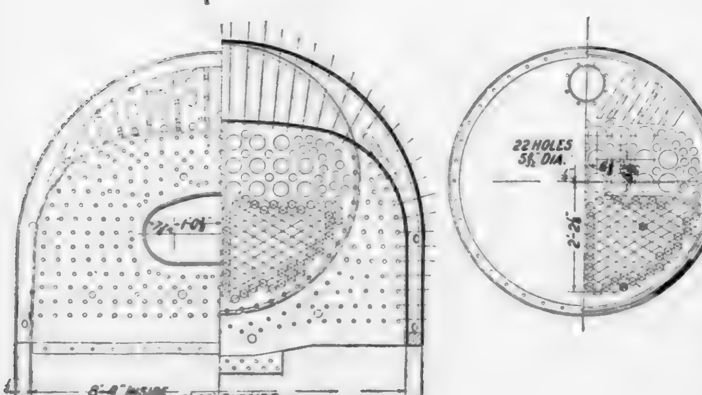


STANDARD PACIFIC TYPE LOCOMOTIVE, CLASS G'—CANADIAN PACIFIC RAILWAY.









STANDARD TEN-WHEEL LOCOMOTIVE, CLASS D10; BOILER, CLASS D11.

—CANADIAN PACIFIC RAILWAY.

since the adoption of the standard parts, and, while, since their design was under consideration at the time the standards were being adopted, they bore some direct influence upon the adoption, they can in general be considered as an illustration of how the standard parts can be used in designing new power of an entirely different type. Reference to the table of parts shown in our April issue, will make clear the exceedingly broad application of the parts suitable for the consolidation and ten-wheel standard engines to this Pacific type. While, of

course, in such matters as frames and boilers it is necessary to use new designs, in most other respects, such as cylinders, engine trucks, driving boxes, frame fittings, etc., standard parts are applicable.

In the table herewith will be found the general dimensions of class G2. The class G1, as mentioned above, differs in size of drivers and length of flues, hence in heating surface. There is also a difference in the length of the grate, which for the class G1 is 70 by 93⅝ ins., giving a grate area of 45¼ sq. ft. The heating surface for this class is: tubes, 2,777 sq. ft.; firebox, 180 sq. ft.; total, 2,957 sq. ft. These engines weigh 214,300 lbs., of which 139,300 or 65 per cent. is on drivers. They have 21 by 28-in cylinders with piston valves, and give a tractive power of 30,400 lbs. As will be seen in the table the B. D. ratio (tractive effort x diameter of drivers ÷ by heating surface) is 670, being lower than for any of the other standard engines, as would be expected, when it is considered that these engines are to do their best work at high speed with a short cut-off. From an examination of the ratios it would seem that they have sufficient boiler power to be capable of handling as heavy a train as the tractive power will permit under adverse conditions. The boiler for the class G2 is illustrated herewith and it can be seen that the shell is very long, comprising three sheets, the centre one being the connecting sheet, and that the front flue sheet is set back into the barrel about 20 ins., being 41⅝ ins. from the centre of the stack. The front barrel is 66 ins. inside diameter and the dome sheet is 74 ins. The width of the mud ring differs from the standard one in front where it is 5 ins. instead of 5½. It will be seen that the grate is on a slight slope forward, and that its front end is further below the bottom row of flues than is usual in this type of engine. The arch tubes snown in this illustration were not used.

The engines in both of these classes are equipped with C. P. R. superheaters of the latest design, giving a superheating surface of 630 sq. ft. The large tubes for the superheater pipes are 5 ins. in diameter and 22 ins. in number. The other fire tubes, of which there are 209, are 2¼ ins. in diameter and are set at 3-in. centres.

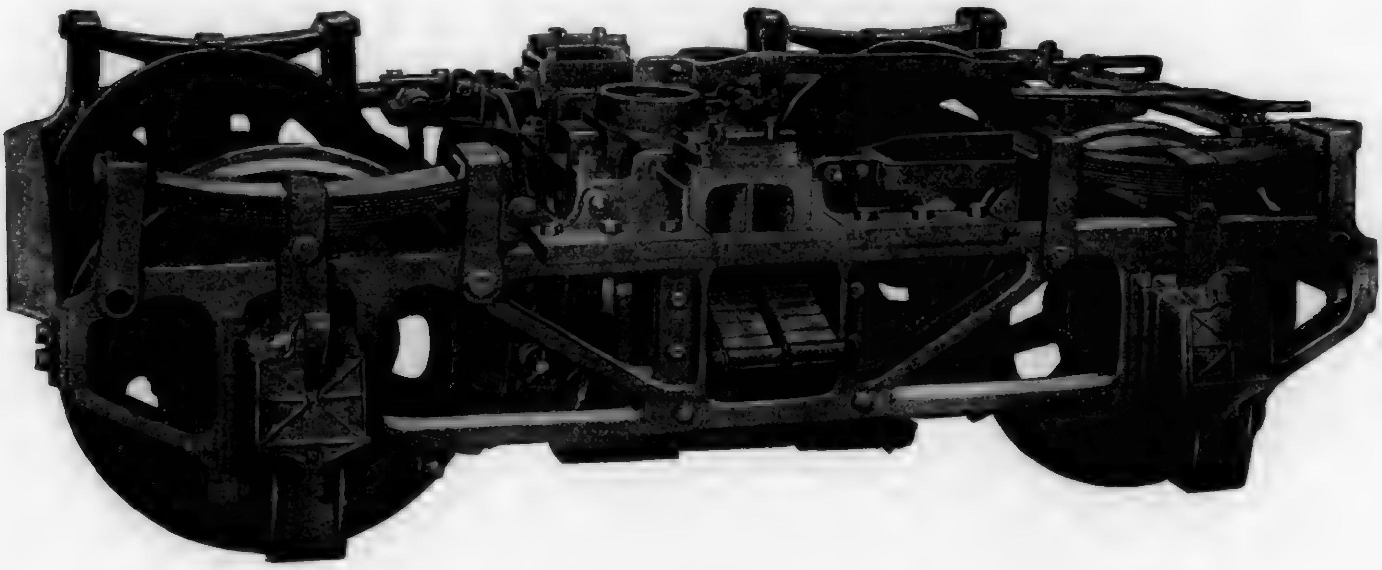
(To be continued.)

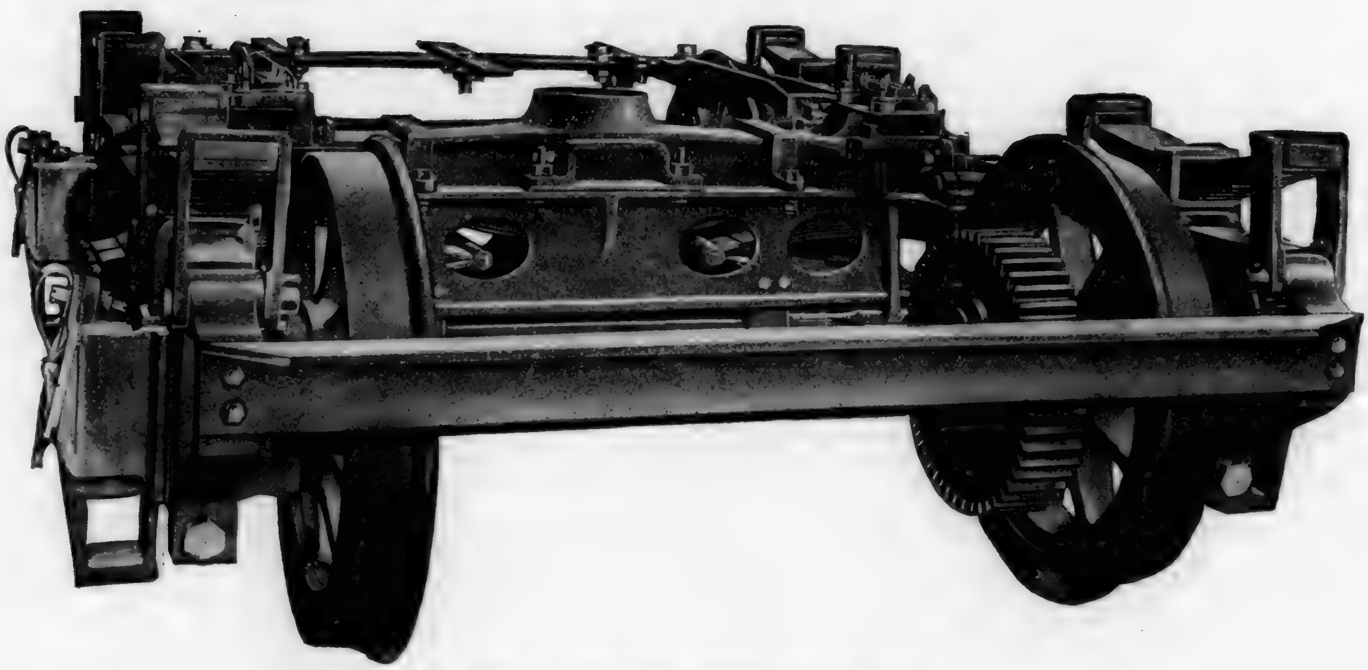
GENERAL DIMENSIONS OF STANDARD LOCOMOTIVES, CANADIAN PACIFIC RAILWAY.

CLASS.	M-4	D-10	D-11	G-2
Service	Fgt.	Fgt. & Pass.	Fgt. & Pass.	Passenger
Fuel	Bit. Coal	Bit. Coal	Culm	Bit. Coal
Tractive power	36,800 lbs.	33,300 lbs.	33,300 lbs.	30,400 lbs.
Weight in working order	186,200 lbs.	190,000 lbs.	192,000 lbs.	214,300 lbs.
Weight on drivers	163,700 lbs.	141,000 lbs.	141,000 lbs.	139,300 lbs.
Weight on leading truck	22,525 lbs.	49,000 lbs.	51,000 lbs.	40,000 lbs.
Weight on trailing truck	....	....	....	35,000 lbs.
Weight of engine and tender in working order	307,650 lbs.	312,700 lbs.	314,700 lbs.	337,000 lbs.
Wheel base, driving	15 ft. 10 in.	14 ft. 10 ins.	14 ft. 10 in.	13 ft. 0 ins.
Wheel base, total	24 ft. 4½ in.	26 ft. 1 in.	26 ft. 1 in.	33 ft. 7 ins.
Wheel base, engine and tender	53 ft. 4¼ in.	54 ft. 6¾ ins.	52 ft. 11¼ ins.	59 ft. 11¾ ins.
RATIOS.				
Weight on drivers ÷ tractive effort	4.45	4.24	4.24	4.6
Total weight ÷ tractive effort	5.06	5.7	5.72	7.05
Tractive effort x diam. drivers ÷ heating surface	880	870	905	670
Total heating surface ÷ grate area	55.5	49.2	30.4	62.5
Tube heating surface ÷ firebox heating surface	13.4	12.4	11.3	15.3
Weight on drivers ÷ total heating surface	68.7	58.	61	44.6
Total weight ÷ total heating surface	78.1	78.7	83	68.7
Volume both cylinders	11.22 cu. ft.	11.22 cu. ft.	11.22 cu. ft.	11.22 cu. ft.
Total heating surface ÷ vol- cylinders	212	215	206	278
Grate area ÷ vol. cylinders	3.83	4.37	6.78	4.46
CYLINDERS.				
Kind	Simple	Simple	Simple	Simple
Diameter and stroke	21 x 28 ins.	21 x 28 ins.	21 x 28 ins.	21 x 28 ins.
VALVES.				
Kind	Piston	Piston	Piston	Piston
Diameter	11 ins.	11 ins.	11 ins.	11 ins.
WHEELS.				
Driving, diameter over tires	57 ins.	63	63	69 ins.
Driving journals, main, diameter and length	9½ x 12 ins.	9½ x 12 ins.	9½ x 12 ins.	9½ x 12 ins.
Driving journals, others, diameter and length	9 x 12 ins	9 x 12 ins.	9 x 12 ins.	9 x 12 ins.
Engine truck wheels, diameter	31 ins.	31 ins.	31 ins.	30 ins.
Engine truck journals	6 x 10 ins.	6 x 10 ins.	6 x 10 ins.	6 x 10 ins
Trailing truck wheels, diameter	....	....	....	44 ins.
Trailing truck, journals	....	....	....	7 x 14 ins.
BOILER.				
Working pressure	200 lbs.	200 lbs.	200 lbs.	200 lbs.
Outside diameter of first ring	6[illegible] ins.	60⅝ ins.	60⅝ ins.	66 ins.
Firebox, width and length	65¼ x 96⅝ ins.	69⅞ x 102⅛ ins.	100 x 110 ins.	67⅞ x 102⅛ ins.
Firebox, water space	F5½, S4½, B3½	5½-4½-3½ ins.	....	....
Tubes, number and outside diameter	22 & 244-5 & 2 in.	266-2 in.	244-2, 22-5 ins.	209-2¼, 22-5 ins.
Tubes, length	14 ft. 1⅝ in.	14 ft. 2⅞ ins.	13 ft. 7⅛ ins.	20 ft. 0 ins.
Heating surface, tubes	2,216 sq. ft.	2,233 sq. ft.	2,125 sq. ft.	2,931 sq. ft.
Heating surface, firebox	165 sq. ft.	180 sq. ft.	188 sq. ft.	191 sq. ft.
Heating surface, total	2,381 sq. ft.	2,413 sq. ft.	2,313 sq .ft.	3,122 sq. ft.
Superheater heating surface	375 sq. ft.	378 sq. ft.	307 sq. ft.	530 sq. ft.
Grate area	43 sq. ft.	49.5 sq. ft.	76.25 sq. ft.	48 sq. ft.
Smokestack, diameter	16½ ins.	14½ ins.	14½ ins.	14½ ins.
Smokestack, height above rail	15 ft. 1 3-16 ins.	15 ft. 2 ins.	15 ft. 2 ins.	15 ft. 3-16 ins.
Centre of boiler above rail	9 ft. 3½ ins.	9 ft. 5½ ins.	9 ft. 5½ ins.	9 ft. 4 ins.
TENDER.				
Weight, light	51,450	52,700	....	52,700
Wheels, diameter	33 ins.	33 ins.	33 ins.	34 ins.
Journals, diameter and length	5½ x 10 ins.	5½ x 10 ins.	5½ x 10 ins	5½ x 10 ins
Water capacity	5,000 gals.	5,000 gals.	5,000 gals.	5,000 gals.
Coal capacity	10 tons.	10 tons.	10 tons	10 ton

MOTOR AND TRAILER TRUCKS FOR THE NEW YORK CENTRAL ELECTRIC SERVICE.

The accompanying illustrations show the motor and trailer trucks for the suburban electric cars now being built for the New York Central & Hudson River Railroad. The design of both trucks, and especially of the motor truck, is radically different from that of trucks now used under electric cars in this country. They are notable because of their simple design, the small number of parts and the substantial construction. In these respects they correspond more nearly to the trucks used under our heavier passenger cars, and the cost of maintenance should be low. The design of the motor truck is similar to that of the trucks furnished to the Paris-Orleans Railway of France by the American Locomotive Company several years ago, which have given very satisfactory results in service. The motor truck with gears weighs 15,000 lbs., and complete with the two 200 h.p. motors, one on each axle, it weighs 26,760 lbs. The trailer truck weighs 11,400 lbs. The estimated light weight of the car complete is 102,600 lbs.



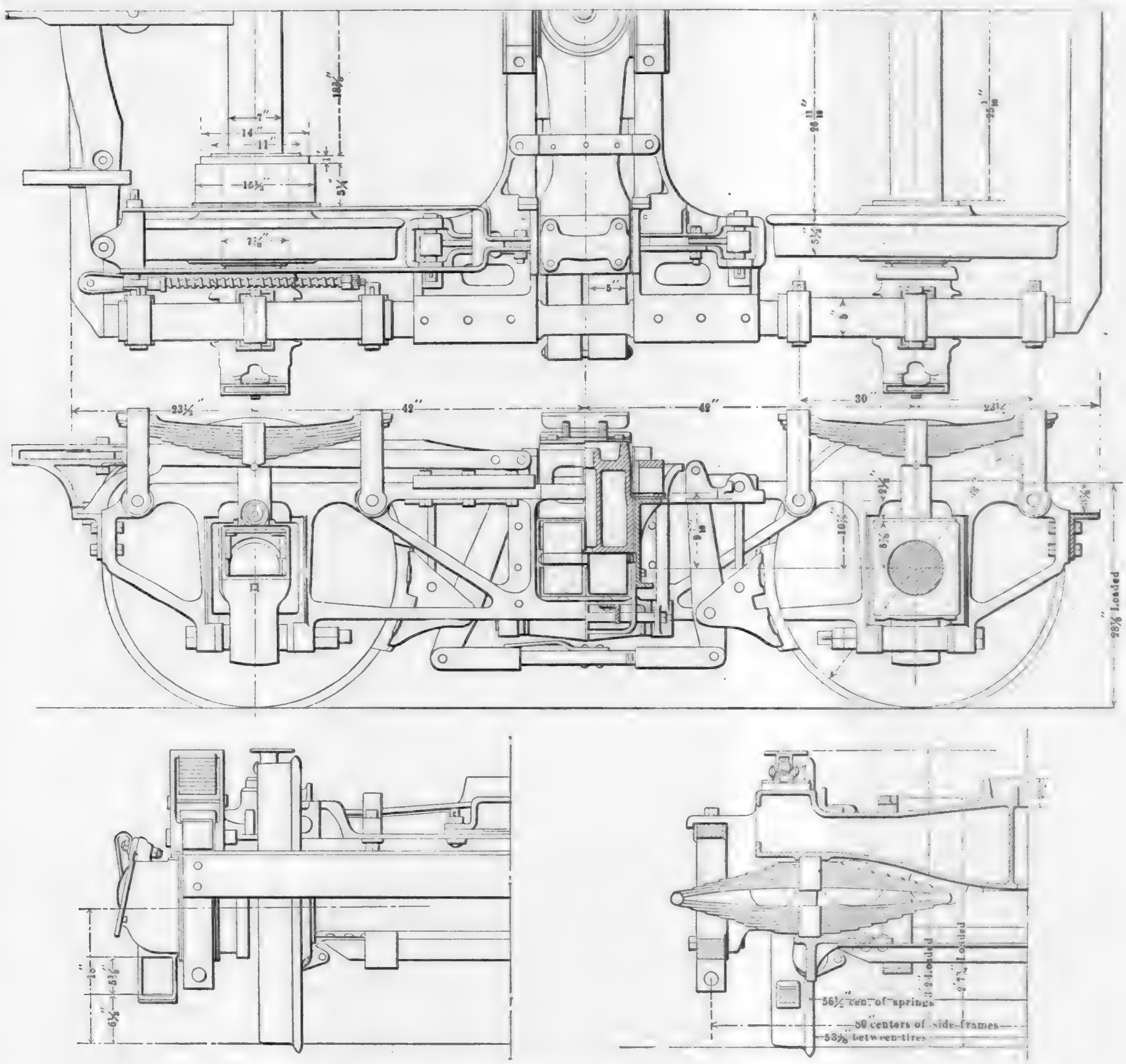


VIEWS OF NEW YORK CENTRAL MOTOR TRUCK.

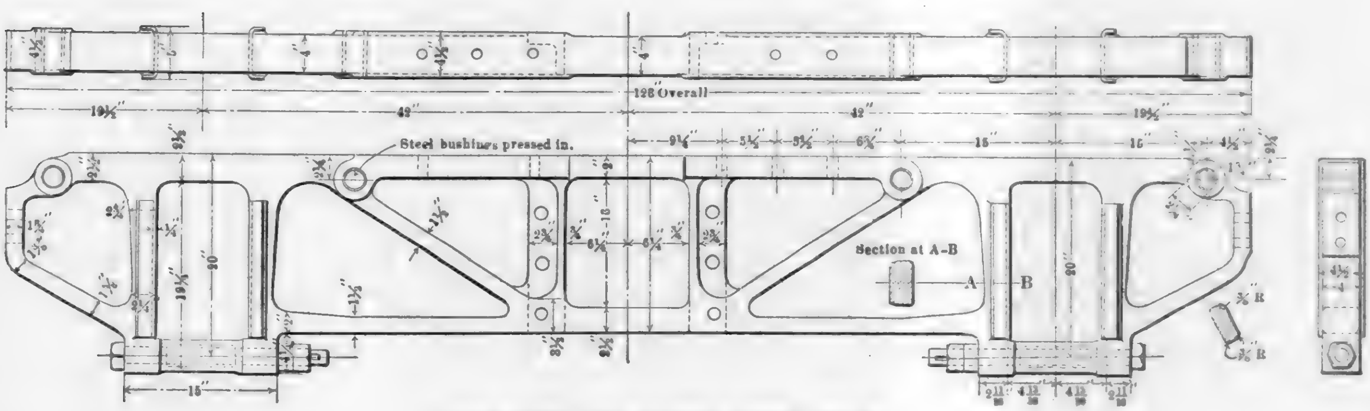
MOTOR TRUCKS.

The motor trucks have a wheel base of 7 ft. and are equipped with steel-tired wheels 36 ins. in diameter. The design of the cast-steel side frame, the absence of equalizers, the method of spring suspension and the application of the journal boxes are in many respects similar to corresponding features in locomotive construction. The absence of equalizers and the open design of the side frame make it possible to readily give the truck a careful inspection when in service. The cast-steel side frame, shown in detail in one of the drawings, is designed for a low-fibre stress in all parts. The pin holes are fitted with 2¼-in. steel bushings. The frames are tied together at the ends by 4 by 6 by ½ in. angles.

The cast-steel transoms are of channel section 11½ ins. high at the centre and ⅝ in. thick; the upper flanges are 3½ ins. wide and the lower ones 2¾ ins. Near the ends the top flange is widened out to form a bracket for the suspension of the spring and brake hangers. This bracket is so designed that the end of the spring hanger is slipped into a cavity from underneath and is thus covered over, preventing dirt from getting on the bearing. A flange near each end of the transom projects upward, providing a larger chafing surface for the bolster, which at this point is of extra depth, and prevents it from binding. At the end of the transom is a bracket for attachment to the vertical bar of the side frame and the top



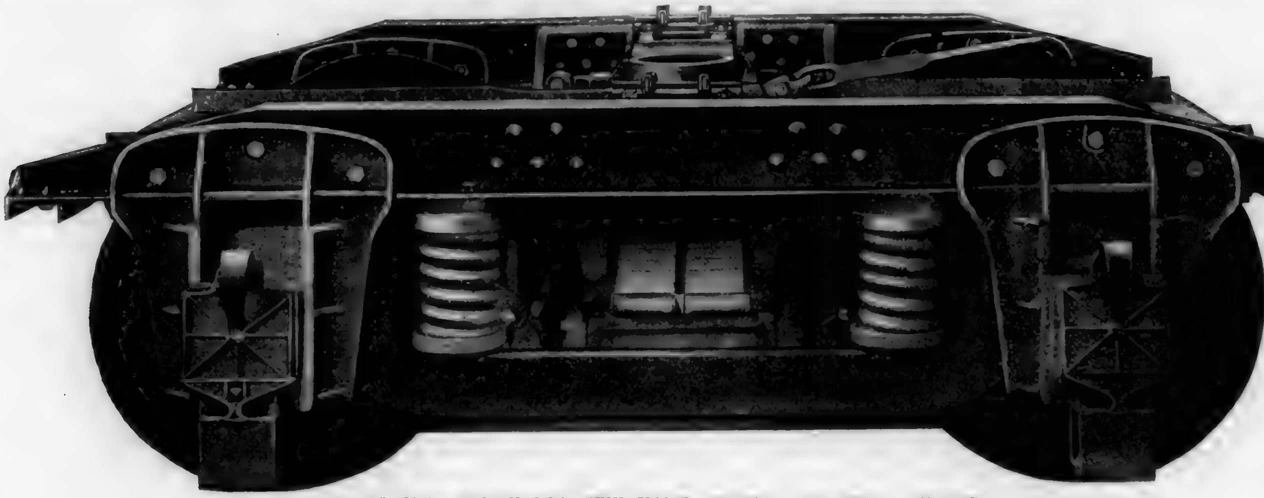
MOTOR TRUCK—NEW YORK CENTRAL & HUDSON RIVER RAILROAD.



CAST STEEL SIDE FRAME—MOTOR TRUCK.

of the transom lips over the top of the side frame, thus taking the strain off the bolts, which secure it to the side frame, and reducing the number of bolts required to a minimum. The transom at the centre is just high enough to take the motor nose (the motor application is not shown on the engravings), which rests on a case-hardened plate, held in place by the same bolts which secure the strap for the motor nose.

The cast-steel bolster is of I section and for a short distance at the middle and ends is of a double box section. No chafing plates are used, but the wearing surfaces at both the middle and ends of the bolsters are very large, so that the wear will probably be very slight, and as these surfaces are comparatively deep and the clearance between the bolster and the transoms is only ⅛ in., there will be no tendency for the bolster to cant or bind. The bolster is 11½ ins. deep at the centre and 6 ins. at the ends, except where it is raised to take



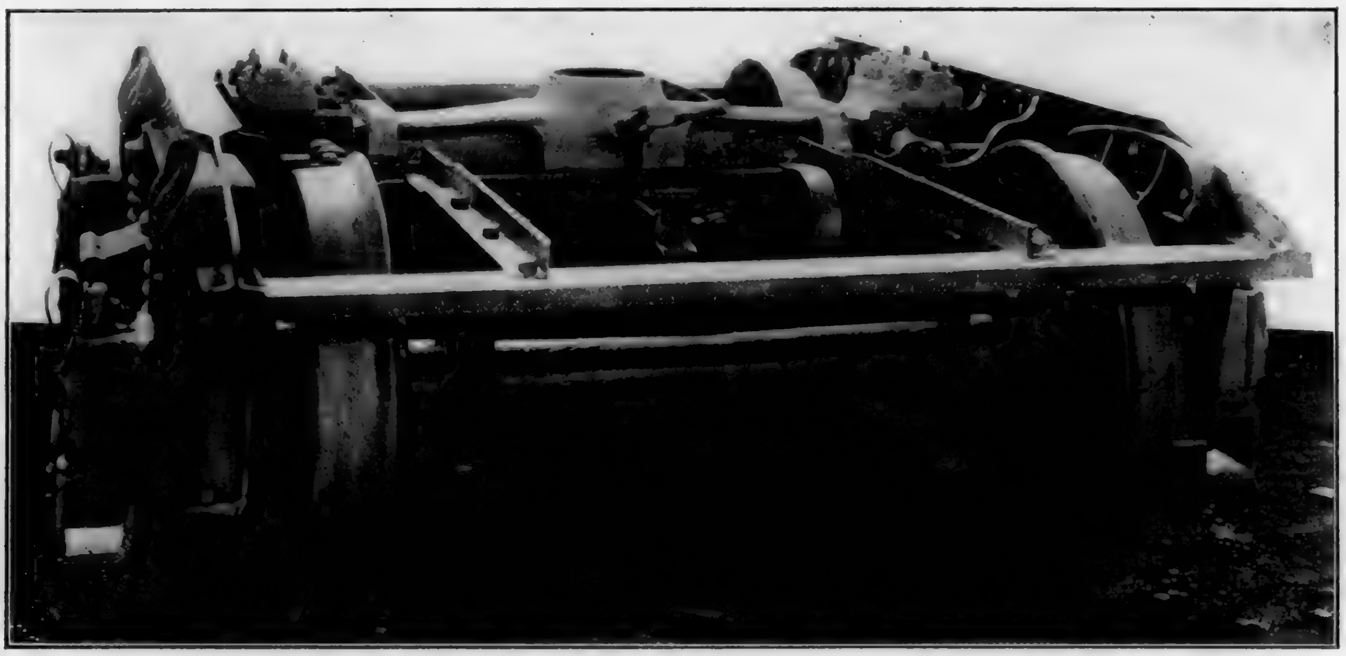
TRAILER TRUCK FOR NEW YORK CENTRAL ELECTRIC SERVICE.

the Norwood side bearings. The centre plates are cast integral with the bolster and the wearing surfaces are machined.

The spring plank is suspended from the brackets on the transoms by 1 by 1½ in. steel bars. The ends of the spring plank are steel castings, which are connected by two 2½ by 2½ by ⅜ in. angles, to which they are riveted. Trunnions are cast on these castings and are fitted with case-hardened sleeves, which are pressed on. The swing links slip over these sleeves. Because of the small amount of clearance it is impossible to extend the trunnions far enough to take a key and lugs are therefore forged on the links and they are tied together by a 1-in. bolt, as shown. The spring bands fit into recesses in the spring plank and bolster castings.

Symington journal boxes are used. The lower ends of the pedestal jaws are tied together by binders similar to those used in locomotive construction. The shoes are made of ¼-in. steel pressed to shape, and as they fit tightly on the jaws no bolts are required and they do not rattle. A U-shaped piece of 1 by 4 in. steel bar passes over the frame and rests on top of the journal box; it has a 1-in. pin, resting in the milled slot at the top, which supports the spring band. The projections or lugs at the lower front part of the journal boxes are designed to take 4 by 6 in. beams, to which the third rail shoes are to be attached. The journal brasses and wedges are standard for the 5½ by 10 in. journal, except that the ends of the brasses are brought down ⅜ in. lower than usual in order to better withstand the thrust of the motors. The axles have an enlarged wheel fit 7⅞ ins. in diameter. A projection is cast on the inside of the wheel over which the large gear, which is cut from hard rolled steel similar to tire steel, is shrunk on. Steel gears of this kind give much more satisfactory results than castings.

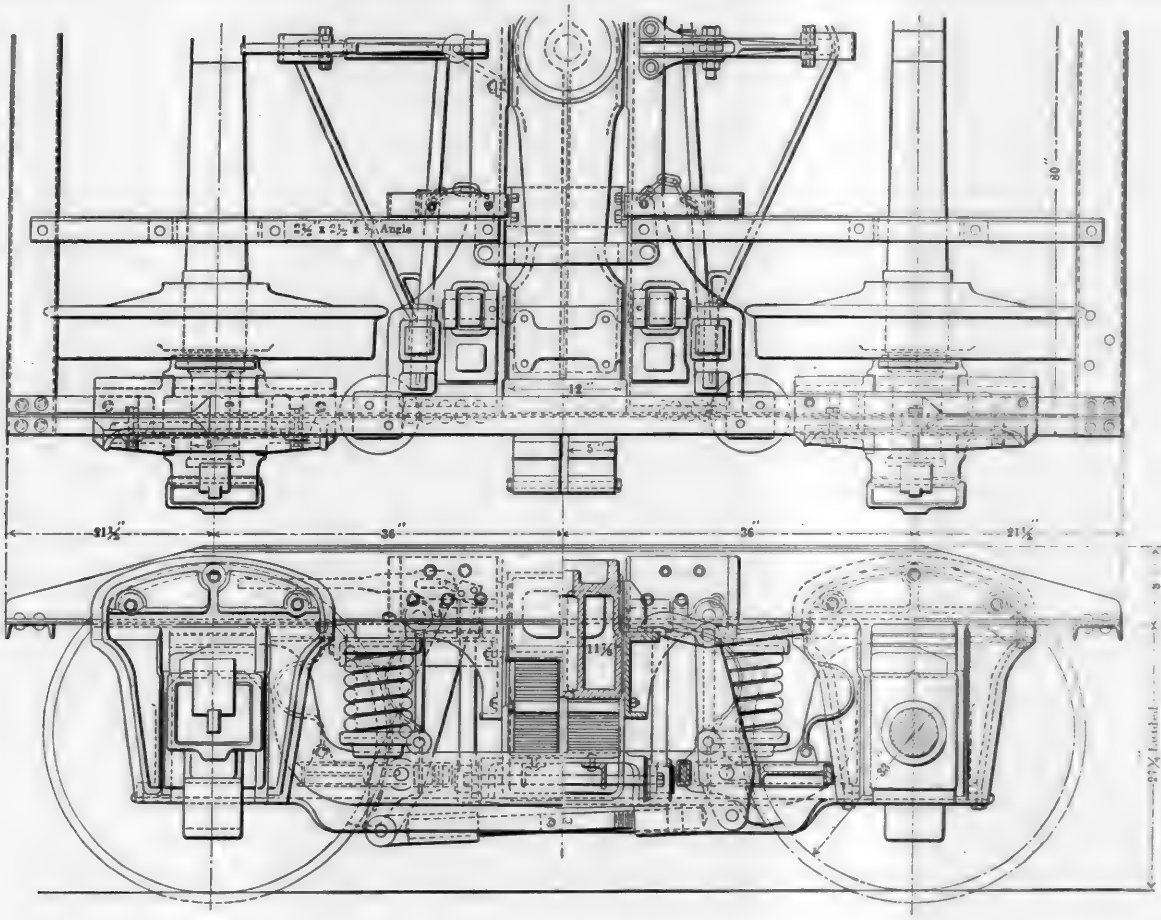
The space occupied by the motor does not allow the use of brake beams, and each brake-head is therefore hung individually from the brackets cast on the transoms. The lower ends of the two brake levers on each side are connected by turnbuckles for the adjustment of the brakes. The turnbuckle studs are of square section and are locked at each quarter turn by the flat spring shown in the illustrations. The levers at each side of the truck are connected by loop bars, which straddle the wheels, to the ends of a cross bar, which is 1 by 5½ ins. in section at the centre. This bar is supported and guided by two castings attached to the angle which connects the side frames. The connection to the main brake rod is unique and is designed to reduce the strains on the rods when the car is on a curve. A roller is fitted in the fork of the main rod and bears against the curved surface of the cross bar. The spiral springs attached to either end of the bar return the brakes to the release position.



TRAILER TRUCK FOR NEW YORK CENTRAL ELECTRIC SERVICE.

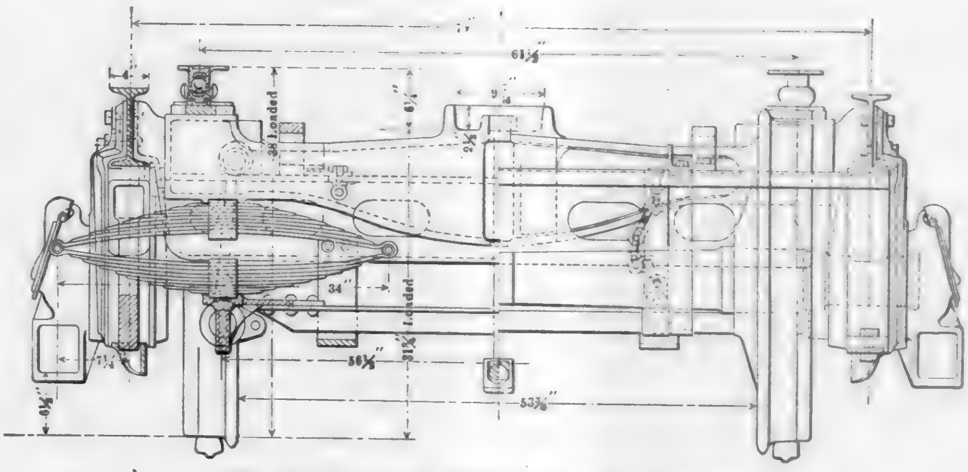
TRAILER TRUCK.

The trailer truck has a wheel base of 6 ft. and is equipped with 33-in. steel-tired wheels. The general design is quite similar to that of the four-wheel metal trucks used on the



PLAN AND SIDE ELEVATION OF TRAILER TRUCK.

New York Central Lines, which are giving very satisfactory results for heavy passenger service. The engravings illustrate the truck so clearly that a brief description will suffice. The side member is an 8-in. I beam, to which the pedestal castings are bolted. The pedestals are tied at the lower ends by a light strap. The equalizer bars are of the usual design. The side members are connected at the ends by 5-in. channels. The bolster is the same as the one used on the motor truck. The transoms are of cast-steel and are also quite similar to those used on the motor truck, except for slight differences in the design of the brackets for suspending the spring plank and brake hangers and also of the brackets at the ends for attachment to the side frame. The spring plank is of the same construction as the one on the motor truck.

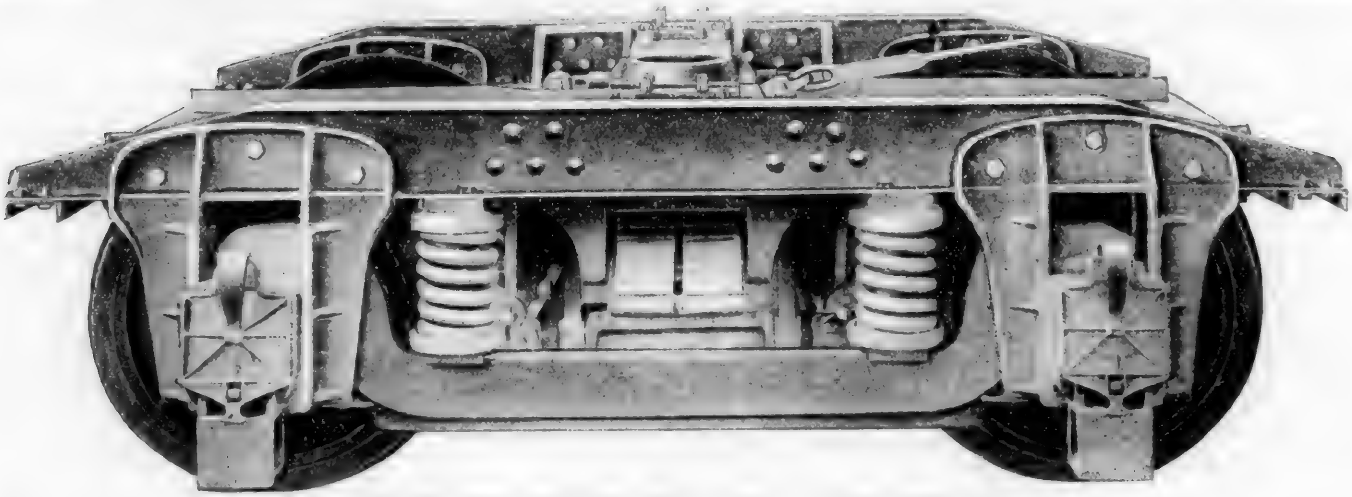


END ELEVATION AND SECTION OF TRAILER TRUCK.

The axles are M. C. B. standard with 5 by 9 in. journals. Symington journal boxes are used with a lug cast at the lower front end for carrying the beam to which the third rail shoes are attached. The application of the brake rigging is clearly shown in the drawings. The trussed brake beam, designed by the American Locomotive Company, consists of two rectangular bars which are welded together at their ends.

The motor trucks were designed by the American Locomotive Company in consultation with the motive power department of the New York Central & Hudson River Railroad and the trailer trucks are adapted from designs of similar trucks which have been in service on the New York Central Lines for several years.

A VALUABLE TOOL FOR ROUNDHOUSES.—In addition to the list of tools that Mr. Bentley has enumerated for the roundhouse, we have discovered in the past year that a small lathe mounted on a wagon that can be drawn to any pit in the roundhouse by a couple of men, and has been a very good investment. We drive it with an air motor. With the class of power that we have we find it necessary very frequently to renew splice bolts in frames and such as that, and this lathe we use for the purpose of fitting the bolts right on the ground. Say we have an engine around in the fiftieth stall; we draw the lathe around there, and the bolts are taken there in the rough and are turned and driven in right at the spot. We find that an advantage over carrying the bolts to some place in the shop and then back again to be tried, and a little more taken off from them, and finally driven in where they belong, sometimes tight, and sometimes not as tight as they should be.—*Mr. D. R. MacBain, before Western Railway Club.*



TRAILER TRUCK FOR NEW YORK CENTRAL ELECTRIC SERVICE.

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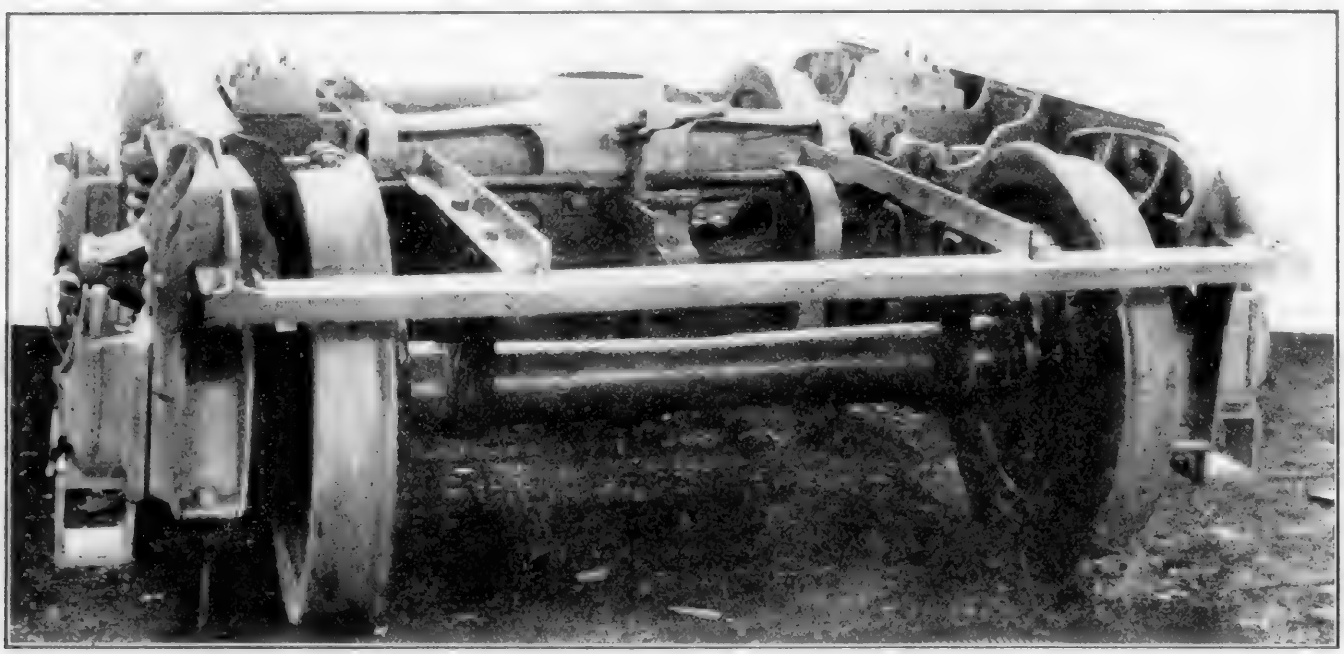

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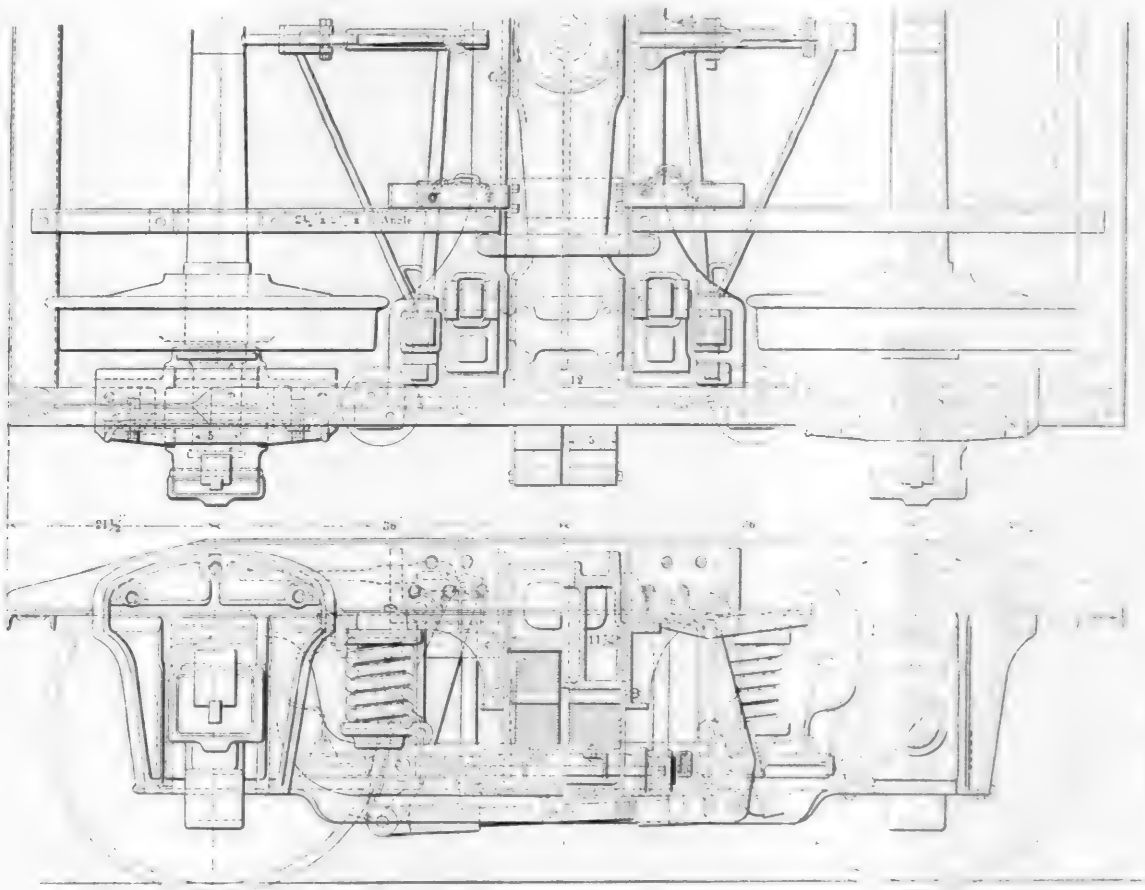
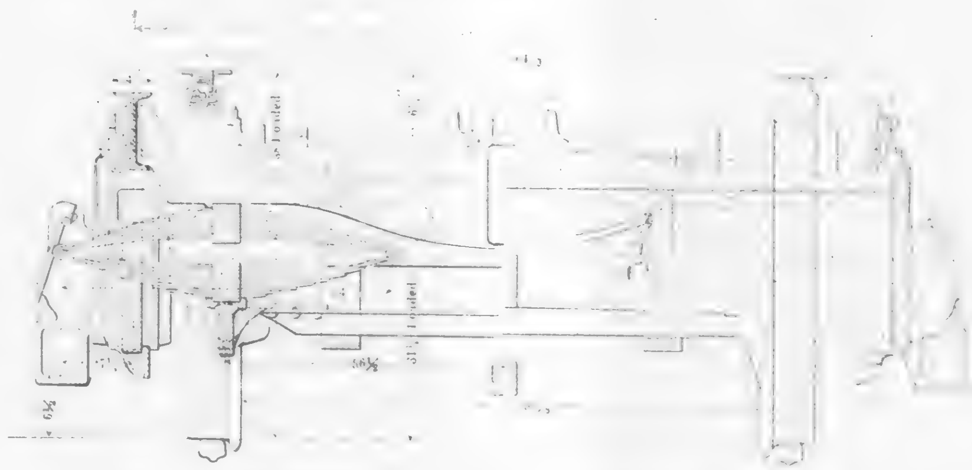


PLAN AND SIDE ELEVATION OF TRAILER TRUCK.



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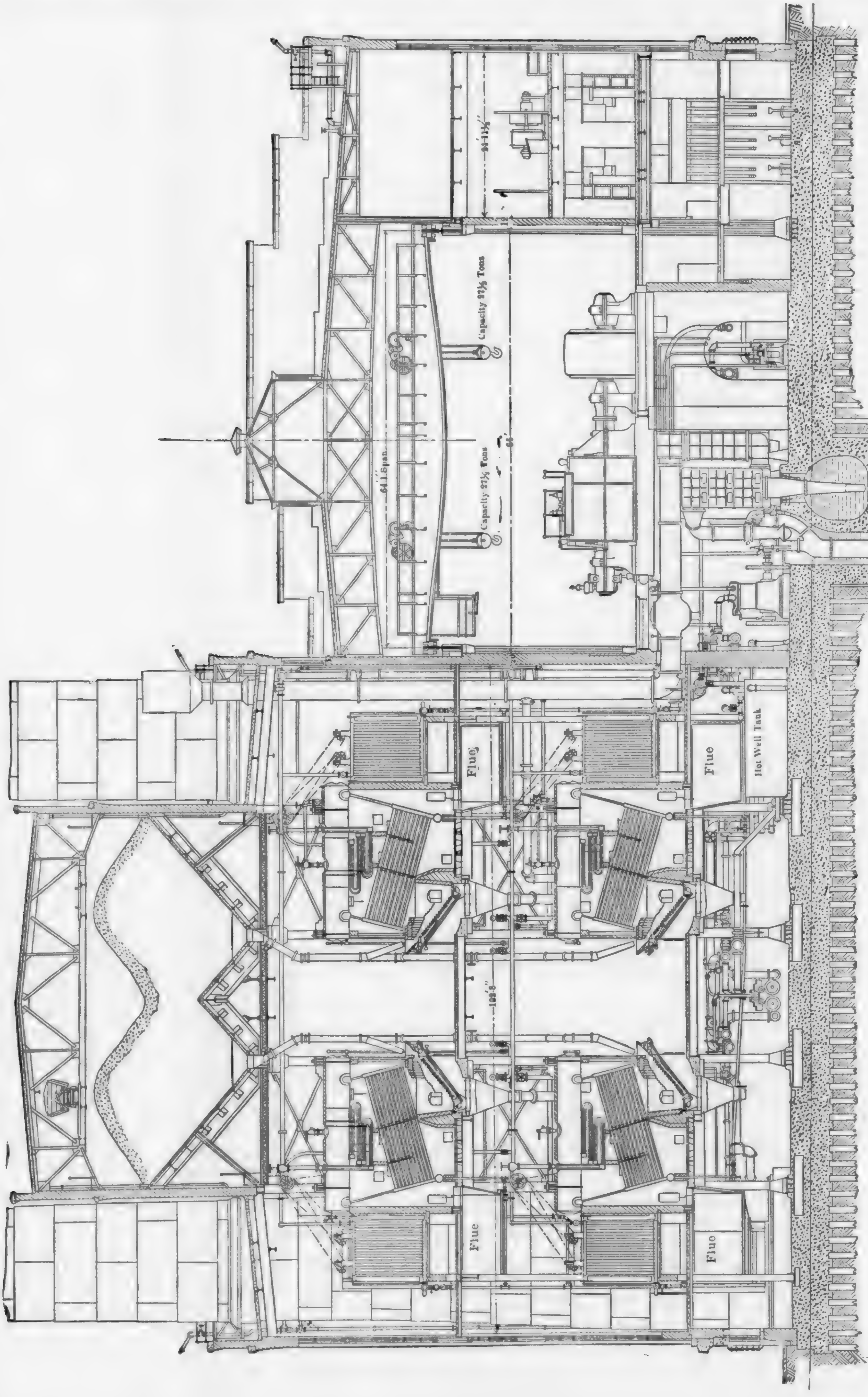
The axles are M. C. B. standard with 5 by 9 in. journals. Symington journal boxes are used with a lug cast at the lower front end for carrying the beam to which the third rail shoes are attached. The application of the brake rigging is clearly shown in the drawings. The trussed brake beam, designed by the American Locomotive Company, consists of two rectangular bars which are welded together at their ends.

The motor trucks were designed by the American Locomotive Company in consultation with the motive power department of the New York Central & Hudson River Railroad and the trailer trucks are adapted from designs of similar trucks which have been in service on the New York Central Lines for several years.

A Valuable Tool for Roundhouses.—In addition to the of tools that Mr. Bentley has enumerated for the roundhouse, we have discovered in the past year that a small lathe mounted on a wagon that can be drawn to any pit in the roundhouse by a couple of men, and has been a very good investment. We drive it with an air motor. With the class of power that we have we find it necessary very frequently to renew splice bolts in frames and such as that, and this lathe we use for the purpose of fitting the bolts right on the ground. Say we have an engine around in the fiftieth stall; we draw the lathe around there, and the bolts are taken there in the rough and are turned and driven in right at the spot. We find that an advantage over carrying the bolts to some place in the shop and then back again to be tried, and a little more taken off from them, and finally driven in where they belong, sometimes tight, and sometimes not as tight as they should be.—*Mr. D. R. MacBain, before Western Railway Club.*



CROSS SECTION OF POWER HOUSE AT LONG ISLAND CITY.—PENNSYLVANIA, NEW YORK & LONG ISLAND RAILROAD.

THE PENNSYLVANIA RAILROAD'S EXTENSION TO NEW YORK AND LONG ISLAND.

LONG ISLAND CITY POWER HOUSE.

The Pennsylvania Railroad Company has had plans for establishing a terminal for its lines on Manhattan Island under consideration for a number of years, and at present has all parts of the work of tunneling under the Hudson River, the Island of Manhattan and the East River and the erection of a very large passenger station in New York City under way. The earliest plans for entrance onto the island contemplated a bridge over the Hudson River, but the thorough demonstration that electric traction is practical for heavy train units made possible the many advantages of entering the city by means of tunnels. The plan, as finally rounded out and being followed, embraces not only a Pennsylvania terminal on the island, but also a through connection with New England and the railroad system of Long Island. The first announcement that this plan had been adopted was made in May, 1902, and since that date the project in all its features has been actively under way, and at a recent date the first link in this great work, the Long Island City power station, was completed.

In this and future articles we propose to take up and describe such features of this power station, the transmission line and the new rolling equipment, as will be of interest from a mechanical and electrical point of view.

This power station is an example of the most modern design of a source of power for heavy electric traction, and includes in its equipment the latest features of steam generating and converting apparatus as well as electric distributing and controlling methods. Briefly, it consists at present of 32 Babcock and Wilcox water tube boilers set in batteries of two boilers each, eight batteries on the first floor and eight on the second floor immediately over them; three 5,500 k.w. generating units driven by Westinghouse-Parsons steam turbines delivering alternating current at 11,000 volts, and high tension controlling devices connecting a simple but highly efficient distributing scheme to the high tension feeder cables leaving the power house. The unit system of installation has been followed throughout; that is to say, four batteries of boilers, two on the first and two on the second floor are connected directly to one generating unit, and each unit is to feed a certain part of the electrical distributing system when the plant is operating at full load. However, while the plant is designed on that general principle, the boilers, engines, generators and distributing system are so connected by cross-connections that the power house as a whole presents a very flexible arrangement, allowing any boiler, or number of boilers, to operate any generating unit, which will furnish current for any feeder cable or circuit.

LOCATION.—This station is located at Hunter's Point, Long Island City, adjacent to the bank of the East River and about opposite the foot of Thirty-fourth Street, New York City. This location was chosen for a number of reasons, principal among which was the close proximity to the East River, which permits a convenient and ample supply of circulating water for the condensers and cheap coal delivery. It is also at a point adjacent to this site that the tunnel under the East River will emerge and connect with the lines of the Long Island Railroad, the suburban sections of which are concentrated here. There is also a freight yard of the Long Island Railroad located at this point, which permits the cheap handling of both coal and ashes by rail, as well as a minimum expense for delivering building materials and equipment during construction.

STATION CAPACITY.—At the time the design was undertaken the extent of electrification in sight was such as to necessitate a station capacity of not less than 50,000 k.w. and probably more. The rectangular shape of the lot, practically 200 by 500 ft., made it possible to plan a station which could be built in sections and eventually occupy the whole block. The adopted design will finally permit of fourteen 5,500 k.w. generating units. However, as this amount of power will not be needed for some years to come, the station, as now built, consists of less than half of what the finished building will be, and has room for six 5,500 k.w. units and two 2,500 k.w. units of the same type, which will be used for lighting. At present but three of the main units have been installed.

BUILDING.

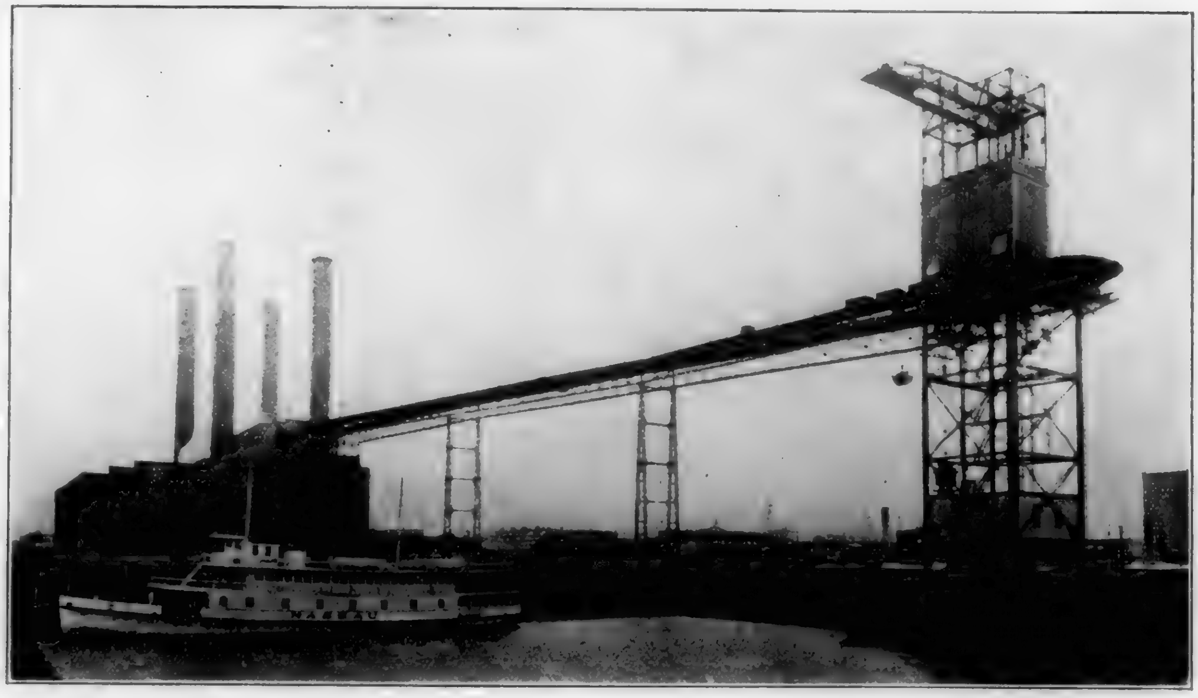
DIMENSIONS.—The present building, the general appearance and construction of which is clearly shown in the illustrations herewith, is 200 by 262 ft., outside measurement. It is divided into three distinct sections lengthwise, of which the boiler house, 103 ft. wide, is the largest. This section is 82 ft. high to the top of its parapet and has above it the coal pocket enclosure, which is 60 ft. wide with its parapet 118 ft. above the street level. The engine room and electrical galleries are located in the other main sections of the building, the former 66 ft. wide and the latter 25 ft. wide. This section is but 70 ft. high. The boiler house has two floors, the first of which is 16 ft. above the basement and the second 35 ft. above the first floor. In the engine room there is but one floor, which is 23 ft. 6 ins. above the basement. This room has a clear height of 40 ft. from the floor to the roof trusses. The electrical section has properly four floors, the second of which is on a level with the engine room floor. This sub-division includes the offices and a small machine shop as well as all of the electrical control apparatus.

VIEW OF POWER STATION AND ASH TOWER.

FOUNDATIONS.—Underlying the whole building is a large monolith of concrete, which is nominally 6 ft. 6 ins. thick, and rests on piles closely driven over the whole area, the spacing being on an average 2 ft. 4 ins. between centres of piles. The total number of piles required for this work was 9,115. They are all driven practically to refusal, and designed to carry a load of 12 tons each. This type of foundation was chosen because it allows future loads to be adjusted to suit conditions, gives a uniformity of settlement throughout, and also that a careful study showed it to be cheaper than disconnected types of foundations on this kind of soil. The top of the piles are cut off 2 ft. 6 ins. below high water level and in a water bearing stratum of river mud which insures perpetual moisture. Underneath the stacks the concrete cap is 8 ft. 6 ins. deep, the piles being cut off 2 ft. lower down.

The flume for the condenser intake and the overflow flume directly above it, traverse the building foundation completely from west to east and are integral with it. Between the power house foundation and the river these two flumes separate so that the discharge is a considerable distance from the intake. Both of these flumes are nominally 10 ft. in diameter, which allows a low velocity of flow even when the power house is in its completed shape. Great care has been taken at the inlet to prevent any possible trouble from its being clogged either by ice or in any other manner, there being a heavy timber ice fender with timbers spaced 4 ins. apart and inclined toward the surface, behind which is a large well having two sets of screens fitted in vertical iron guides. The outer screen is of iron wire with 1 in. mesh and the inner one of copper wire with ½ in. mesh. To prevent any trouble with ice forming in the flume during extreme cold weather a 30-in. connection is taken from the overflow flume, which, if desired, can be opened and allow enough warm water to enter the intake well to prevent an accumulation of ice, even when there is a very moderate load on the power plant. These flumes are built entirely of concrete, being reinforced at such points as are necessary to prevent crushing.

As the intake flume is underneath the overflow, a well is provided at each condenser base at one side of the overflow flume and connecting to the intake flume below. The condenser intake is located in this well and the condenser discharge drops directly into the overflow flume.



VIEW FROM RIVER, SHOWING COAL HOISTING TOWER AND CABLE RAILWAY.

There is a total of 18,000 cu. ft. of concrete in the monolith cap and flume.

SUPERSTRUCTURE.—Like all modern buildings of this class the station consists of steel frame work enclosed in brick walls. The steel work is independent of the walls in this case, with the exception of the south end of the boiler house roof trusses, which are supported by the wall at that point.

The architectural treatment is of the simplest kind, there being nothing of an ornamental nature included. The general design comprises three distinct features, as will be seen from the exterior view, the first being the boiler house with its four independent stacks and its series of single arched window openings extending without interruption past all floors. The second feature is the separate enclosure of the coal bunkers, superimposed on the boiler house longitudinally between the stacks, and the third is the engine house, including also the electrical galleries and offices, which is treated as a separate wing of the main building, connected to and parallel with the boiler house but subordinate thereto. Similar long window openings divide the walls of this part into equal facades.

The arched facade of the superstructure rests upon a basement of rough hewn granite pierced with small heavy grated window openings. Above this the walls are constructed of red brick laid in white mortar. The ash bin, located directly in front of the boiler house, which is so situated in the freight yard that ashes can be dropped from it by gravity into gondola cars, is constructed to harmonize with the main building.

The roof and floors throughout the station building are of concrete reinforced on the Ransome system and carried by the steel frame work. The frames of all doors and windows in the exterior walls are of cast-iron, and so also are the window sashes, which are glazed with rough wire glass. All the sashes are pivoted at the top and arranged to swing outward by a system of operating devices specially designed for this station.

The steel work of the building carries the weight of the rooms and the inner contents, except such portions of the machinery as may be more conveniently carried on separate foundations. The framings for the boiler house and engine room are necessarily quite different in type, as the former has to carry a double tier of boilers with all their appliances, together with a coal pocket of 5,200 tons capacity on top of everything, while the engine room structure carries nothing

but the roof trusses in the engine room. The 55-ton traveling crane spanning the engine room is supported on separate columns.

The stacks are independent of the boiler house, except where they pass through the lower boiler room floor, at which point the floor is built around the stacks. At other points they pass through circular openings, so that there is no stress induced in the structure by a deflection of the stacks. A general idea of the whole steel structure can be obtained from an inspection of the cross-section of the station given herewith. The problem of supporting the large coal bin at such a height, and also of the boilers on the second floor, makes this structure interesting. The bottom of the columns supporting these heavy loads rest on grillages of steel beams imbedded directly in the monolith concrete foundations.

COAL AND ASH HANDLING PLANT.

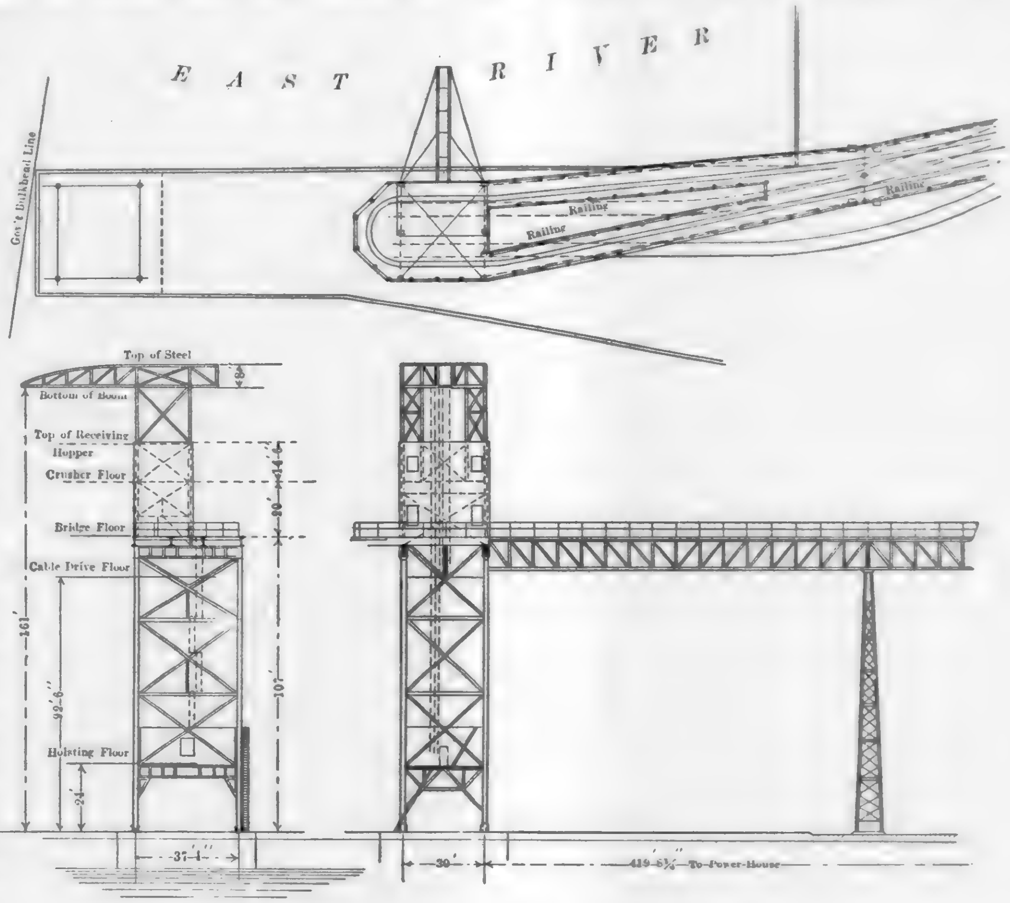
The location of the power station is such that it can receive coal either by water or by rail, but it is expected that most of the supply will be delivered by water, and for handling this a most complete apparatus has been installed.

As shown in one of the illustrations, this consists of a high tower located on a dock about 500 ft. from the power house, and having a boom extending out over the water and a high cable railway connecting to the power house. In brief, the system consists of a clam-shell bucket, which is filled in a barge alongside the dock, hoisted to the boom and then trollied across to the centre of the tower, where it is automatically dumped into a hopper, from whence it passes through the crusher and into the cars on the scale platform below. These cars are carried by a cable railway across and into the boiler house at a height sufficient to allow them to be dumped into the coal bin by gravity. They are automatically dumped without stopping and need no attention until they again return for loading.

The coal hoisting tower consists essentially of four heavy corner columns of box pattern thoroughly braced to each other in all directions, excepting below the engine room floor, where the bracing is omitted in order to allow three railroad tracks on the dock to pass through the tower. The engine room floor is 25 ft. above the dock, and the space here for a height of 14 ft. is enclosed and forms an engine room for the hoisting apparatus. The tower extends in this shape to the level of the railway, which is 107 ft. above the dock; it then continues in a narrower section to a height of 170 ft. above the dock. This upper section carries the hoisting beam, receiving hopper, coal crushing and weighing apparatus and the cable railway machinery. The boom is 68 ft. long and projects 43½ ft. beyond the face of the tower and over the slip at an elevation of 162 ft. above the dock. It consists of two parallel trusses thoroughly braced and connected and carries the track for the trolley carriage from which the hoisting bucket is suspended.

Between this tower and the boiler house structure, a distance of 500 ft., there are four spans of bridge construction carrying the cable railway. Of the three piers required for these four spans, two are simple design of steel bents shaped like the letter A but elongated, and the third is formed by carrying up the steel structure required for the ash bin. The two outermost spans of this bridge are 140 ft. 6 ins. and the third is 149 ft. long, and the span from ash tower to the boiler house is 70 ft.

The ash bin consists of an enclosure of brick walls around the supporting steel columns. The bottom of the bin is 20 ft. above the railroad track which runs through the base of the tower, and the ashes are handled through dumping gates into gondolas standing on this track. The ashes are handled from the power house through a telpherage system, which hoists the buckets from the boiler room basement to the bridge, at an elevation of 69 ft. above the street, where they are automatically transferred across and dumped into the ash bin. The capacity of the bin is 300 tons.



PLAN AND ELEVATION OF COAL HOISTING TOWER.

The hoisting tower is what is called the "one-man" type, i. e., the hoisting and dumping machinery is all under the control of one man, who is situated in the engine room but a short distance above the barge from which the coal is being taken. The coal is hoisted in a 2-ton bucket, which is raised and lowered by a two-cylinder, 15x24-in. Lidgerwood type of hoisting engine with Stephenson link motion. The bucket is so counter-balanced that when lowered its speed cannot exceed 1,000 ft. per minute, although when hoisting its maximum speed is about 1,400 ft. per minute. The opening and closing of the bucket is done by a "biter" engine, which is of the 8x10-in. Lidgerwood type. This engine can also be used to drive a winch on the dock. The trolley motion for running the bucket in and out along the boom is operated by a 6x8-in. Lidgerwood engine.

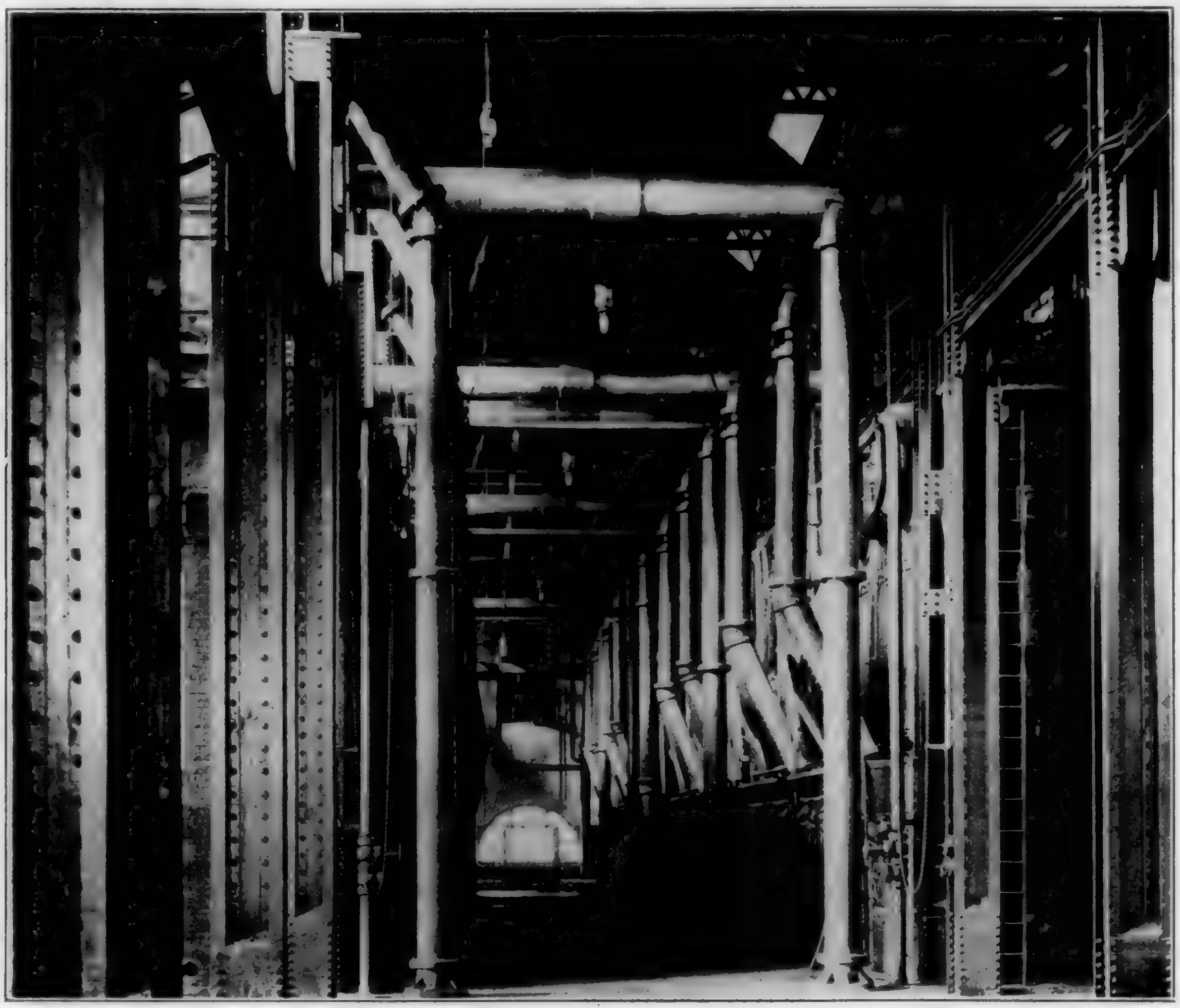
The complete operation is as follows: The bucket is lowered into the barge with the jaws open and the sharp edges of the bucket dig into the coal to a sufficient depth to allow the enclosure of a full load as soon as the jaws are closed. The closing of the jaws is done by the "biter" engine, which operates through a series of steel ropes working around sheaves, and brings the jaws of the bucket together without lifting it out of the barge. When the pocket is closed the hoisting engine starts automatically and continues hoisting until the bucket reaches its predetermined height of about 150 ft. in the air, where the hoisting ceases and the trolley motion

starts automatically, running the bucket along the boom until it is over the receiving hopper, and then automatically starting the "biter" mechanism in the reverse direction and dumps the load. The return movement is controlled by the operator. Full sets of limiting and safety devices, as well as indicators in the engine room, are installed. The bucket can complete a round trip in 45 seconds. The machinery for hoisting and trolleying was designed and built by the Robins Conveyor Belt Company.

The receiving hopper is built of steel plate and the coal passes through it by gravity to a shaking bottom, which allows certain small bituminous or anthracite coal to pass around the crusher to the loading hopper and delivers the large coal to the crusher below which has a capacity of 400 tons in five hours. The cable railway is capable of handling 150 tons per hour when operating twenty-nine 2 ton cars at a speed of 180 ft. per minute around the track loop. However, there are at present but 10 cars in operation. These are of the side dump type, the sides being designed to swing outward and the bottom being inclined so that the car entirely clears itself upon the opening of the side doors. The tripping device, which automatically dumps the car above the bin, consists simply of a heavy cam bolted to an I beam running directly over the centre of the track. This cam engages an arm projecting up from the car, thus actuating the dumping mechanism. These cams can be located as desired.

The cars are propelled by a ¾ in. six strand wire cable, which is gripped by a simple design of gripping mechanism. The cable is driven by a 7½ by 7 in. Westinghouse engine. This engine is automatically shut down in case cars are not properly released from the cable, which is done automatically at a point near the loading platform, where the cable leaves the roadway and goes over the winding drum.

The ashes are dumped through hoppers in the bottom of the stoker pits into small cars, so constructed that the body is detachable from the truck. After receiving its load the car is run along a narrow gauge railway to a turntable at the west end of the boiler house basement directly under the end of the ash bridge extending into the building. They are then fastened on to the telpherage hoist, which upon being started, automatically hoists them to the height of a 10 in. I beam, which forms the track from the ash bin into the boiler house. It then carries them across, automatically dumping into the ash bin, reverses and returns again to the inner end of the track and lowers to the turntable. The entire cycle of operation is effected by simply throwing the starting switch. However, arrangements have been made for stopping and reversing at any desired point. The time required for one round trip of the bucket, hoisting one ton of ashes from the basement to the ash bin and return, is about 3½ minutes. Proper safety devices are installed wherever necessary.



VIEW OF BOILER FRONTS, SECOND FLOOR.

STEAM GENERATING PLANT.

As was mentioned above and can be seen by the cross section of the plant, the 32 Babcock and Wilcox boilers at present installed are equally divided between two floors and being connected two boilers to a battery gives 8 batteries on the first floor and 8 on the second. These batteries are equally distributed on each side of the plant, all facing on a firing space about 18 ft. in width. One of the interior views shows the appearance of this passage. The boilers are designed for a working pressure of 200 lbs. per sq. in. and each boiler has a total heating surface of 5,243 sq. ft. Each boiler also includes an internal superheater consisting of two sections of tubing arranged like a letter U lying on its side and comprising about 1,116 sq. ft. of superheating surface. Each superheater is capable of superheating the output of a boiler

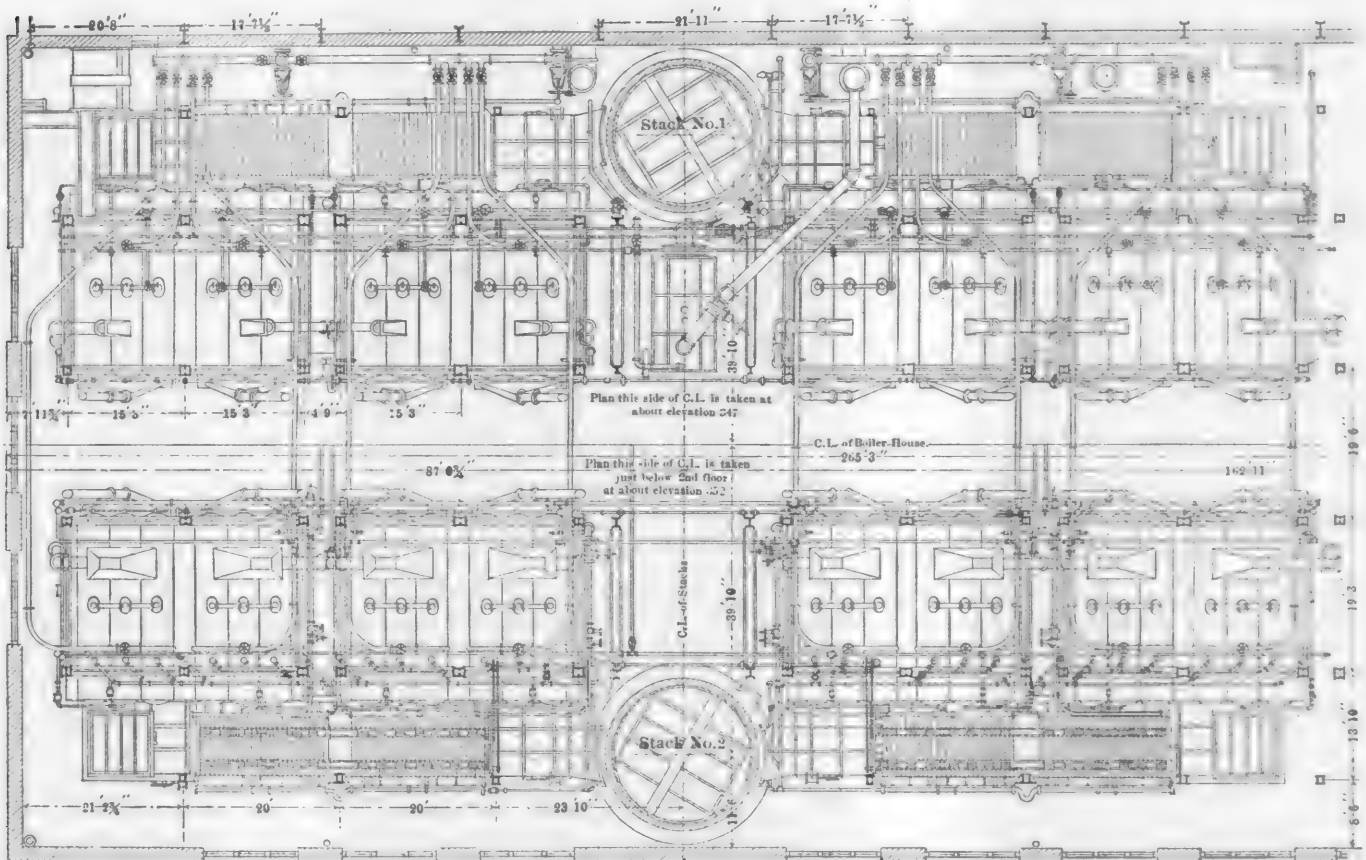
200 degs. F. at 200 lbs. pressure. Provision is made for flooding the superheater when it is out of service. The sections and drums comprising the boilers are hung from wrought iron I beams framed into the building and are thus suspended entirely independently of the brick work. Each boiler has two steam openings, the main nozzle receiving steam from the superheater and the auxiliary nozzle taking saturated steam directly out of the top of the boiler drums.

Each boiler is fitted with a Roney stoker 150 inches wide and having 24 grate bars. The coal supply is fed into a hopper on the boiler front by gravity from the bins above, the connection being made by cast iron piping with suitable valves for controlling the supply. The ashes drop into receiving hoppers at the bottom of the grate and thence discharge through cast iron pipes to openings above the narrow gauge tracks in the basement, from whence the ash cars can be filled. The disposition of the hot gases after leaving the boilers have been very carefully worked out and the arrangement of flues, economizer chambers and dampers is such that while it is intended to work on the unit system, that is by working four boilers together on an economizer directly behind them and thence directly to the stack, the flexibility of the arrangement is so great that it is possible to connect any boiler or number of boilers to any economizer or number of economizers and discharge to any stack, or if desired all the economizers can be cut out and the gases escape direct to the stack.

The economizers are directly behind the boilers and over the flues and each consists of 56 sections of 10 tubes each. The rear wall of the economizer chamber is made of vitrified asbestos air cell board in section, so that in the event of a broken economizer tube it is not necessary to tear down any of the brick work. By the use of these economizers the hot gases are so reduced in temperature as to reach the base of the stack at about 350 degs.

STACKS.—There are four stacks in the present station, although the present equipment uses but two. When the station is extended the number will ultimately be six. The stacks are built of steel, are entirely self-supporting and measure 275 ft. in height. The inside diameter of the straight portion being 17 ft. 10 ins. at the bottom and 16 ft. at the top. They are lined throughout with brick, the spaces between the brick lining and the steel stack being filled with cement mortar. The plates are steel and vary in thickness by sixteenths, from ½ in. at the bottom to 5-16 at the top. Each ring is a cylinder, the lower plates being outside of the upper and each joint carefully caulked. The stack flares at the base and rests upon a cast iron ring 23 ft. in diameter, which in turn is fastened directly to the concrete foundation.

FEED WATER.—The nominal feed water supply to the boilers comes from the hot wells, which receive their water from the main condensers. It is taken from the wells by four boiler feed pumps located in the center of the boiler house basement. The pumps have compound steam ends with steam cylinders 14 and 22 ins. in diameter, the water cylinder being 12 ins. in diameter and 24 in. stroke. The pumps discharge into a pipe making a loop around the ceiling of the pump room and are so connected that they will discharge into either side of the loop, enabling any pump to be cut out for repairs. This loop discharges into the closed heaters, of which there are two, each containing 1,000 sq. ft. of copper tube heating surface. These heaters are supplied with exhaust steam from the auxiliary engines. From the closed heaters the water passes through the economizers and from thence into a loop over the boilers, from which each boiler receives its supply.



PLAN OF BOILER HOUSE.—P. N. Y. & L. I. R. R. POWER STATION.

Special provision has been made to always have on hand a reliable water supply and for that purpose a stand pipe 40 ft. in diameter and 80 ft. high is connected into the 18 in. main of the Montauk Water Company, which leads to the power house. From this 18 in. main, which parallels the building, two 14 in. branches are taken off, and connected into a loop in the inside of the building. From these, in case of an emergency, the boiler feed pumps can obtain their supply. However, under ordinary circumstances this is needed only as "make up" water for the hot wells.

The hot wells, of which there are two for each generating unit, are in the form of open steel tanks about 18 ft. sq. and 6 ft. 6 ins. deep. The water level is maintained constant by a float valve in the tank actuating the governor on the pump

starts automatically, running the bucket along the boom until it is over the receiving hopper, and then automatically starting the "biter" mechanism in the reverse direction and dumps the load. The return movement is controlled by the operator. Full sets of limiting and safety devices, as well as indicators in the engine room, are installed. The bucket can complete a round trip in 45 seconds. The machinery for hoisting and trolleying was designed and built by the Robins Conveyor Belt Company.

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The cars are propelled by a 3/4 in. six strand wire cable, which is gripped by a simple design of gripping mechanism. The cable is driven by a 7 1/2 by 7 in. Westinghouse engine. This engine is automatically shut down in case cars are not properly released from the cable, which is done automatically at a point near the loading platform, where the cable leaves the roadway and goes over the winding drum.

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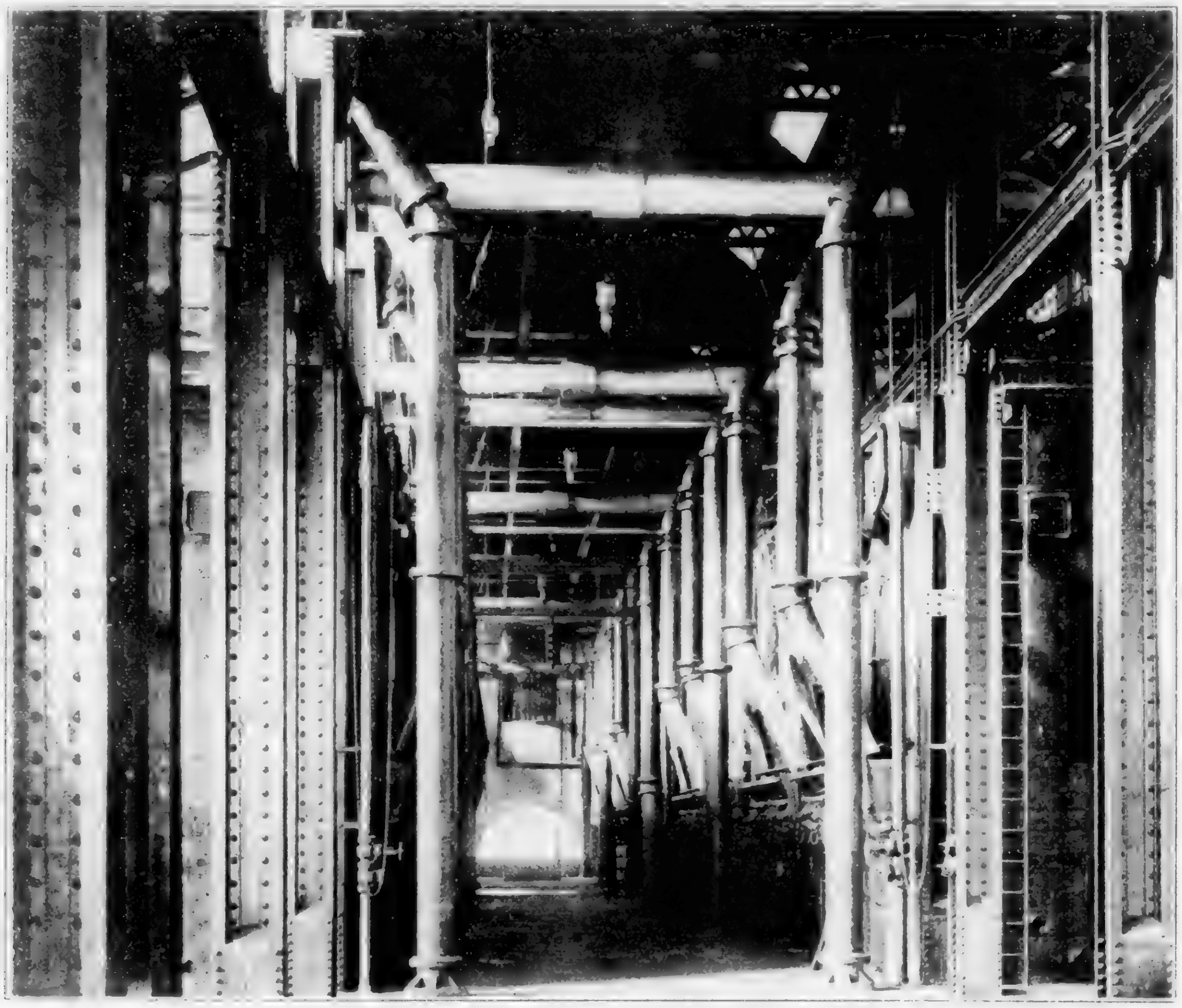

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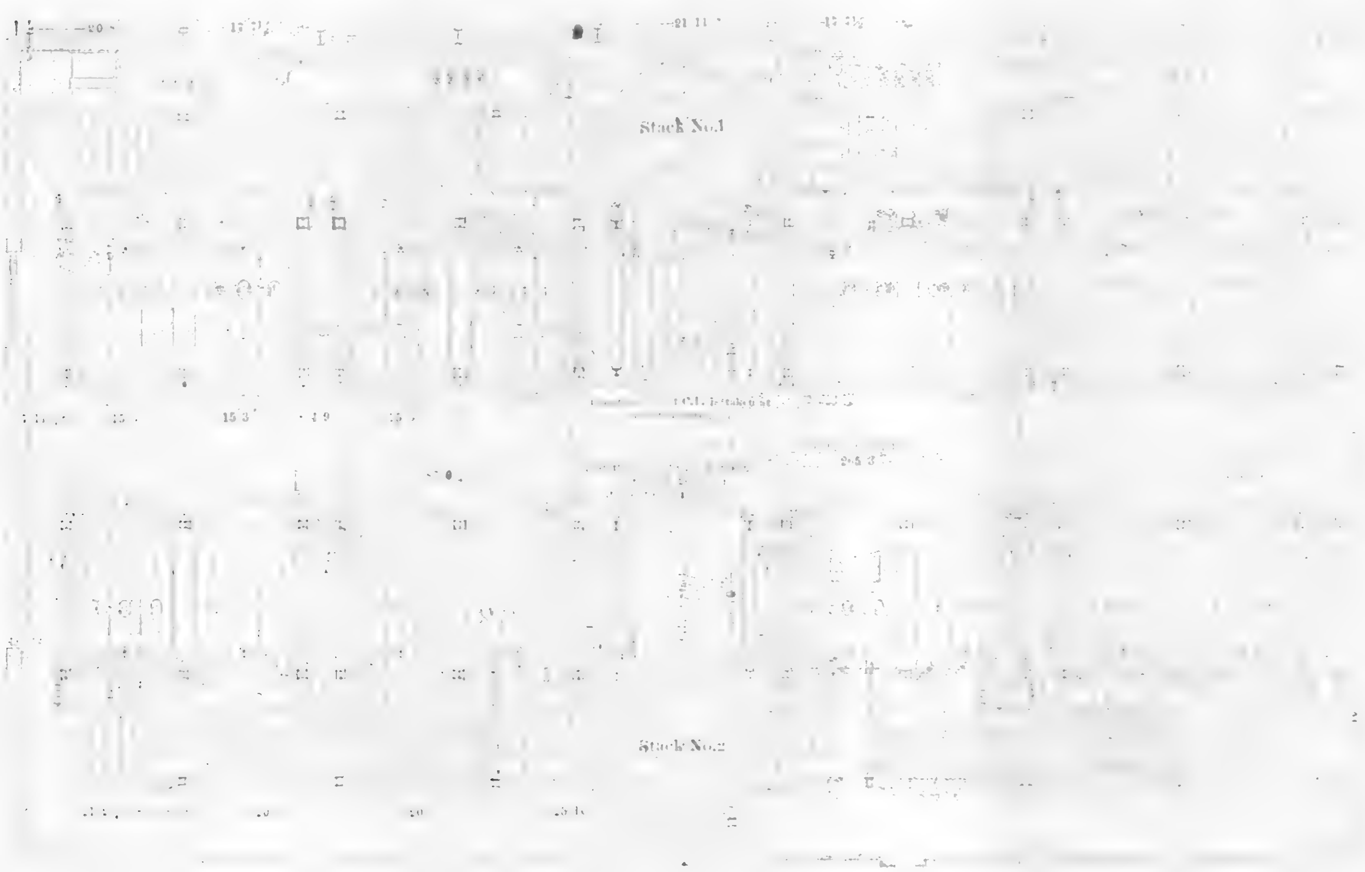

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STACKS.—There are four stacks in the present station, although the present equipment uses but two. When the station is extended the number will ultimately be six. The stacks are built of steel, are entirely self-supporting and measure 275 ft. in height. The inside diameter of the straight portion being 17 ft. 10 ins. at the bottom and 16 ft. at the top. They are lined throughout with brick, the spaces between the brick lining and the steel stack being filled with cement mortar. The plates are steel and vary in thickness by sixteenths, from ½ in. at the bottom to 5/16 at the top. Each ring is a cylinder, the lower plates being outside of the upper and each joint carefully caulked. The stack flares at the base and rests upon a cast iron ring 23 ft. in diameter, which in turn is fastened directly to the concrete foundation.

FEED WATER.—The nominal feed water supply to the boilers comes from the hot wells, which receive their water from the main condensers. It is taken from the wells by four boiler feed pumps located in the center of the boiler house basement. The pumps have compound steam ends with steam cylinders 14 and 22 ins. in diameter, the water cylinder being 12 ins. in diameter and 24 in. stroke. The pumps discharge into a pipe making a loop around the ceiling of the pump room and are so connected that they will discharge into either side of the loop, enabling any pump to be cut out for repairs. This loop discharges into the closed heaters, of which there are two, each containing 1,000 sq. ft. of copper tube heating surface. These heaters are supplied with exhaust steam from the auxiliary engines. From the closed heaters the water passes through the economizers and from thence into a loop over the boilers, from which each boiler receives its supply.

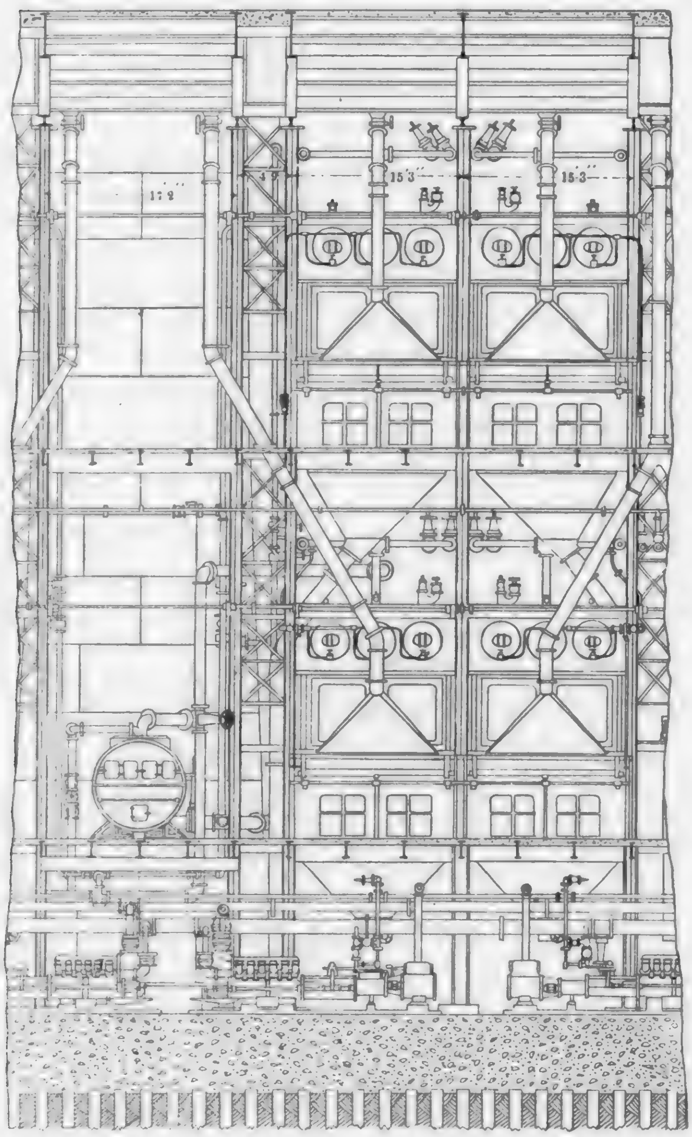
Special provision has been made to always have on hand a reliable water supply and for that purpose a stand pipe 40 ft. in diameter and 80 ft. high is connected into the 18 in. main of the Montauk Water Company, which leads to the power house. From this 18 in. main, which parallels the building, two 14 in. branches are taken off, and connected into a loop in the inside of the building. From these, in case of an emergency, the boiler feed pumps can obtain their supply. However, under ordinary circumstances this is needed only as "make up" water for the hot wells.

The hot wells, of which there are two for each generating unit, are in the form of open steel tanks about 18 ft. sq. and 6 ft. 6 ins. deep. The water level is maintained constant by a float valve in the tank actuating the governor on the pump

connected to the main water supply. This make up water goes directly from the mains to an open Cochrane feed water heater and purifier, which utilizes the exhaust steam from the double acting auxiliary engines and reciprocating pumps. This heater is very large in order to insure slow circulation and is really more of a purifier than a heater. The make up water can, if desired, be used for cooling purposes about the building on its way to the hot wells instead of passing through the heater. Nominally the make up water runs from 10 to 15 per cent. of the entire water consumption of the plant.

Main Steam Piping.—In general the piping for the whole plant is laid out to conform to the lines of the unit system above mentioned, but these units are so interconnected that the greatest possible flexibility is allowed and permits any boilers to be operated and furnish steam for any particular generating unit.

The general arrangement of the superheated steam piping is such that the four boilers on each floor connect unto a manifold and each two manifolds are connected together and



ELEVATION OF BOILERS.

fed into the main steam pipe for one generating unit. A cross connecting or equalizing header connects the different manifolds.

The supports for the main steam piping consist simply of turn-buckle rods suspended from the steel work of the building, the arrangement being such as to afford opportunity for expansion in any direction. The manifolds are supported on springs resting on a platform suspended from the building beams.

There is a system of saturated steam piping for supplying the steam to the steam driven auxiliaries, including the boiler feed pumps, circulating pumps, stoker engines, etc., which is taken only from the boilers located on the engine room side of the boiler house. This steam line forms a loop in the basement, one side being in the boiler house and the other in the engine room basement and having cross connections and proper valves to permit cutting off any particular part.

The piping of all kinds throughout the station is painted in different colors, a distinct color being given to each separate line, i. e., white indicates high pressure steam lines; bright red with black flanges indicates saturated steam lines and Holley system connections; black, boiler feed piping; yellow, exhaust from auxiliary apparatus, etc.

ENGINE ROOM EQUIPMENT.

As stated above, the space in the engine room provides for seven 5,500 k.w. generating units and two 2,500 k.w. lighting units. However, at present but three of the larger units have been installed. These consist of Westinghouse-Parsons steam turbines direct connected to Westinghouse alternating generators of the revolving field type.

The general appearance of the engine room is shown in one of the illustrations herewith and in it the remarkable absence of piping or other obstructions of the floor space will be noticed. The room is spanned by a 55 ton electric crane having two hoists, which was built by the Morgan Engineering Company. The room is well lighted by the large windows at either end and a monitor in the centre of the roof which extends the whole length of the room.

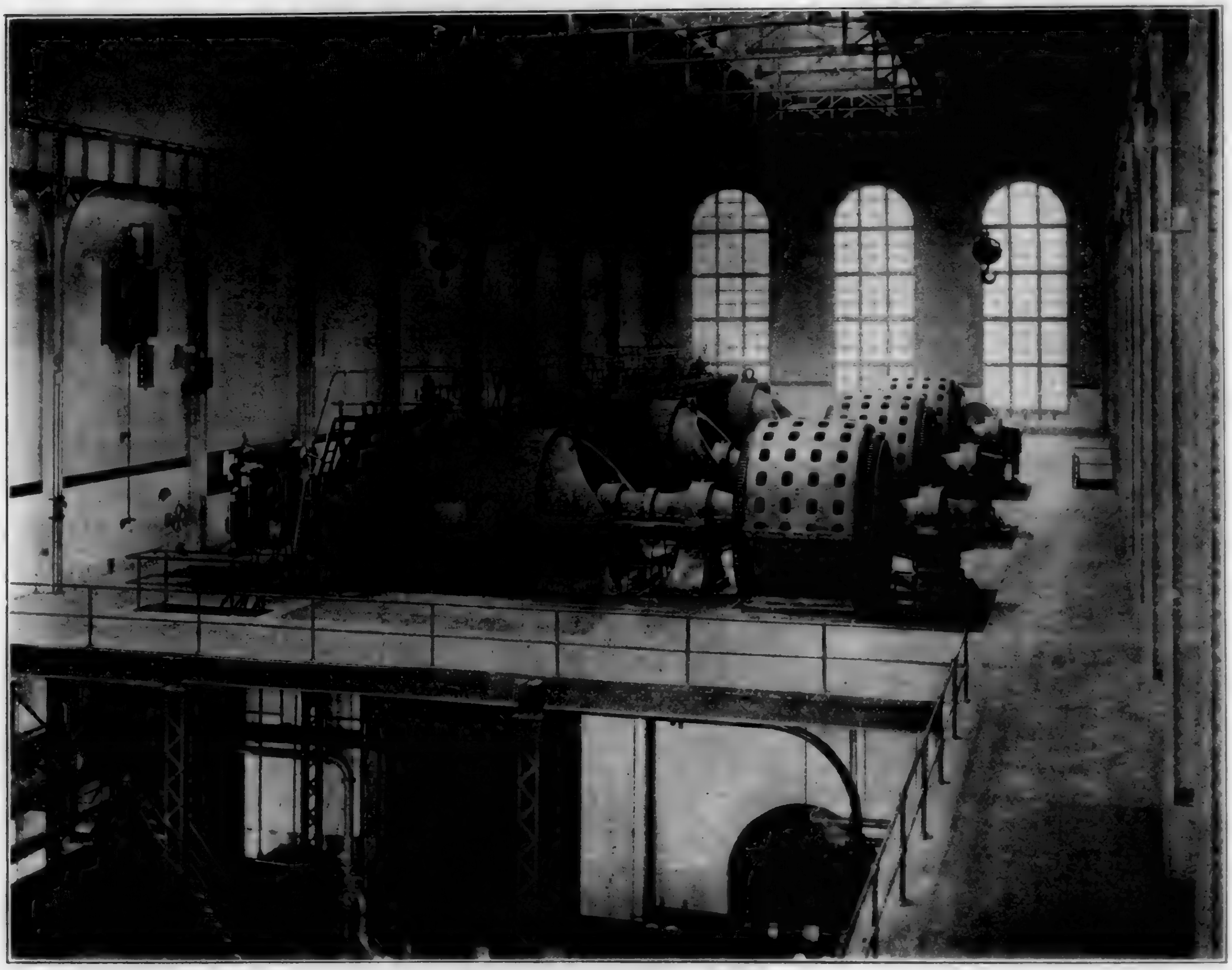
The floor is 23 ft. above the basement floor and each unit rests on a concrete foundation built up from the monolithic slab underlying the whole building. These concrete piers have arched openings below in which is placed the auxiliary machinery for each unit. The piping is located in this basement and is convenient for inspection or repairs.

Turbines.—The turbines are of the single flow type, and develop 5,500 k.w. or about 7,400 h.p. at 175 lbs. steam pressure and 27½ in. vacuum running at 750 r.p.m. The series of blades, the size of which gradually increase from the high pressure toward the low pressure end, are for mechanical convenience divided into three stages and the longitudinal thrust on each of these groups is counterbalanced by a disc of suitable size, which is under a pressure corresponding to the average pressure of the steam against that set of blades. Longitudinal thrust along the shaft is thus entirely eliminated. The smaller blades are made from special bronze and the larger ones from steel and all were originally rolled in a bar of the required cross sections. They are sawed into proper lengths, set in groups in the drum and the cylinder shell and caulked permanently into position. The cylinder casing is made in halves and split horizontally so that the upper part can be lifted off for inspection of the interior.

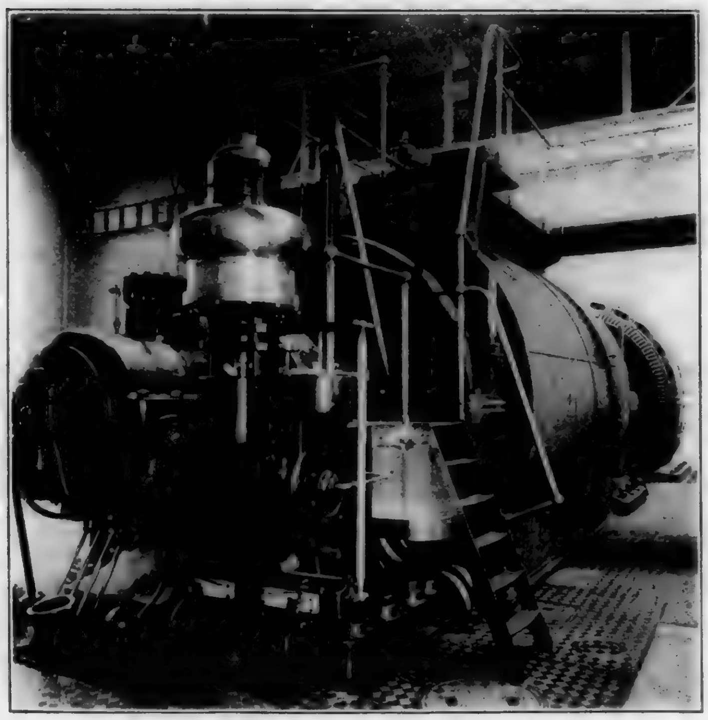
The bearings are supplied with a forced circulation of oil and are also water jacketed. At each end of the cylinder where the shaft passes through, a water seal gland is provided for preventing the leakage of steam along the shaft.

The entire structure of the turbine and generator is carried on a heavy rectangular bed plate, which simply rests upon the foundation but is not fastened to it with anchor bolts. The complete unit is 47 ft. long, 13 ft. wide and 14 ft. high to the top of the gallery railing.

Governor.—The necessity for maintaining a very small variation in speeds on alternating current units connected in parallel is easily recognized, hence the governor which controls the speed of the turbine has been given the closest attention and study and is of particular interest. It consists of a train of levers deriving its motion from worm gearing on the main shaft of the turbine, which actuates an oscillating pilot valve, which in turn actuates the main admission valve of the poppet type by varying the steam pressure against the piston that lifts it. Steam therefore enters the turbine through this main valve in puffs, the duration of



GENERAL VIEW OF ENGINE ROOM.



VIEW OF TURBINE END OF GENERATING UNIT.

which is controlled by the amplitude of vibration of the little pilot valve. The duration of the vibration of this pilot valve is controlled by a system of levers fulcrumed upon the governor spindle. Directly under the governor there is suspended a rocker carrying a weight which can be moved along it from one end to the other by a screw forming the extended shaft of a small motor carried on the rocker. This rocker is continually oscillating, receiving its motion from a vertical rod attached to the outer end of the governor lever system. The inertia of the whole system is altered and its vibration consequently changed by changing the position of the weight on this rocker through the operation of the motor. This motor is controlled by a switch in the operating gallery, so that the switchboard attendant, whose duty it is to throw the machines into parallel, can control the speed of the machine in order to obtain synchronism.

The turbine is also fitted with an automatic safety stop arrangement which cuts off the steam supply automatically in case the speed exceeds the limit. Convenient to each turbine there is also a bracket in the boiler room wall carrying a stop valve by means of which the steam to the units can be cut off in the boiler room without leaving the engine room.

CONDENSERS.—A separate condenser is provided for each turbine and is located in an arch opening in the turbine foundation. Each has 20,000 sq. ft. of cooling surface consisting of 1 in. seamless brass tubes. The exhaust steam enters the condenser at the bottom and the water of condensation is collected from the bottom by the hot well pump. A large dry air pump exhausts the vapor from the top of the condenser and maintains the vacuum. The circulating water enters the tubes at the top, makes three passes and is discharged from the bottom into the overflow flume.

The condensing water is circulated by a 24 in. double suction centrifugal pump driven by a Westinghouse compound

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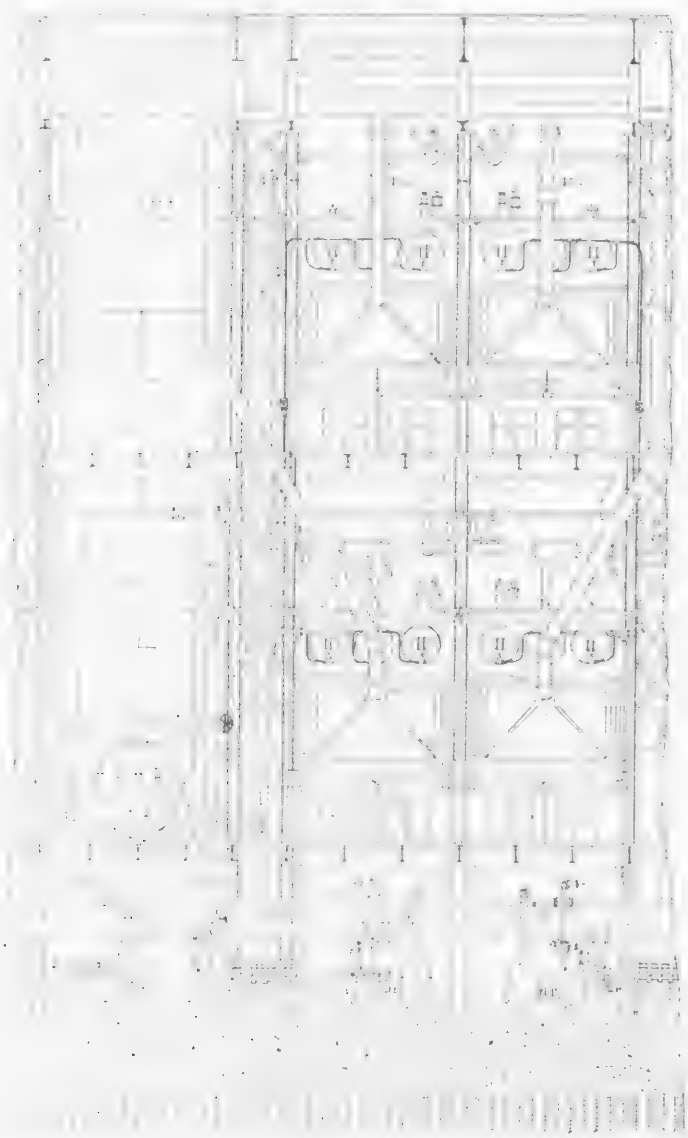

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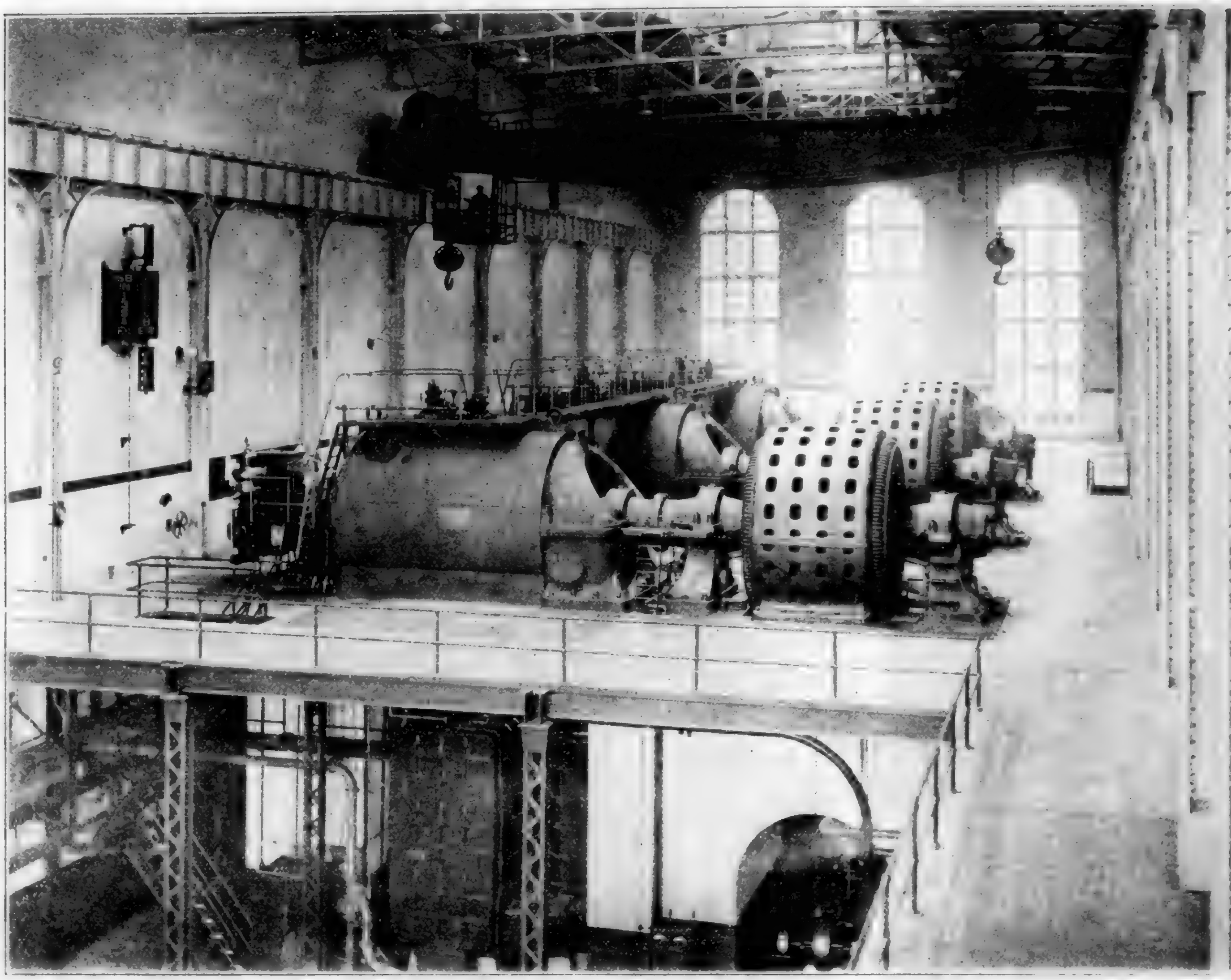
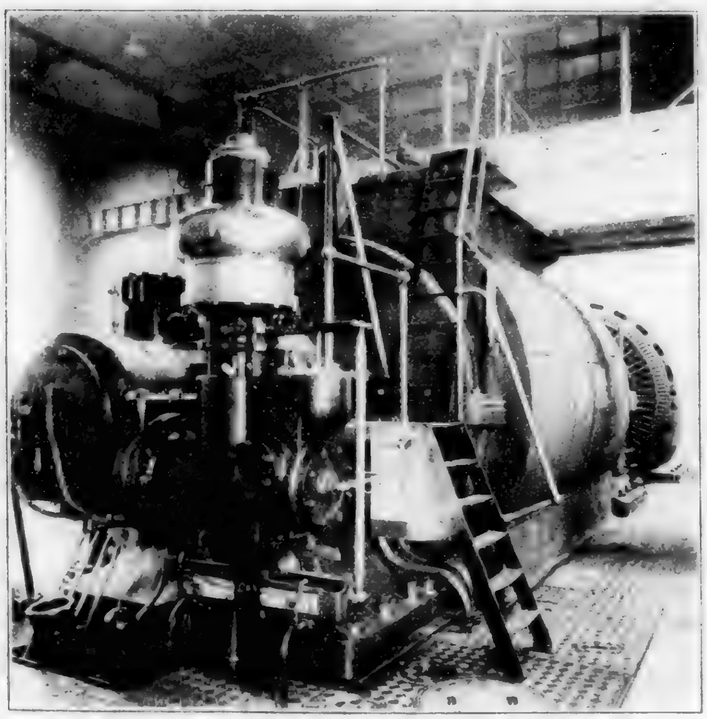


GENERAL VIEW OF ENGINE ROOM.



VIEW OF TURBINE END OF GENERATING UNIT.

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The condensing water is circulated by a 24 in. double suction centrifugal pump driven by a Westinghouse compound

engine direct connected to it. This pump is capable of forcing 20,000 gallons of salt water per minute against a head of 20 ft. The engines develop 175 h.p. noncondensing.

The condensed steam is discharged to the hot well tanks in the boiler room basement by a 4-in. centrifugal pump, direct connected to a 15 h.p. 220 volt direct current motor. A by-pass arrangement is provided for discharging the condensed steam directly into the flume if desired.

The dry air pump is a horizontal steam driven two stage pump with Corliss valves and an automatic governor on the steam end and positive valve motion on the vacuum end. The vacuum cylinders and heads are water jacketed. The steam cylinders are 10 and 24 ins. in diameter and the pump cylinders are 24 ins. in diameter with a 24 in. stroke.

It has been the universal experience that more or less galvanic action takes place in a condenser using salt water, which results in a serious deterioration of the condenser tubes. This is especially true in an electric railway power house and in order to prevent it a unique scheme has been incorporated in this installation. A sufficient number of volt meter readings were taken between the river, the flume and various parts of the piping to indicate what the differences in potential and its polarity were and it was found that there was a possibility of considerable trouble coming from stray electric currents from the street railway systems of the city entering the plant through the water mains and grounding into the river.

To prevent these troubles an insulated joint was placed in each section of piping entering the power house and a circuit provided from the outside piping directly to the flume. In order to neutralize the effect of such current as might leak past the insulated joints a small booster generator is provided, the positive pole of which is connected to the shunt cable just mentioned and the negative pole to seven different points on each condenser. An adjustable rheostat is provided in each of these branches. A differential volt meter is so arranged that it can be plugged into each of these sections and thus the rheostat in that section is adjusted so that a sufficient amount of pressure is on that branch to neutralize the stray currents and keep the potential in the condenser at zero at all times.

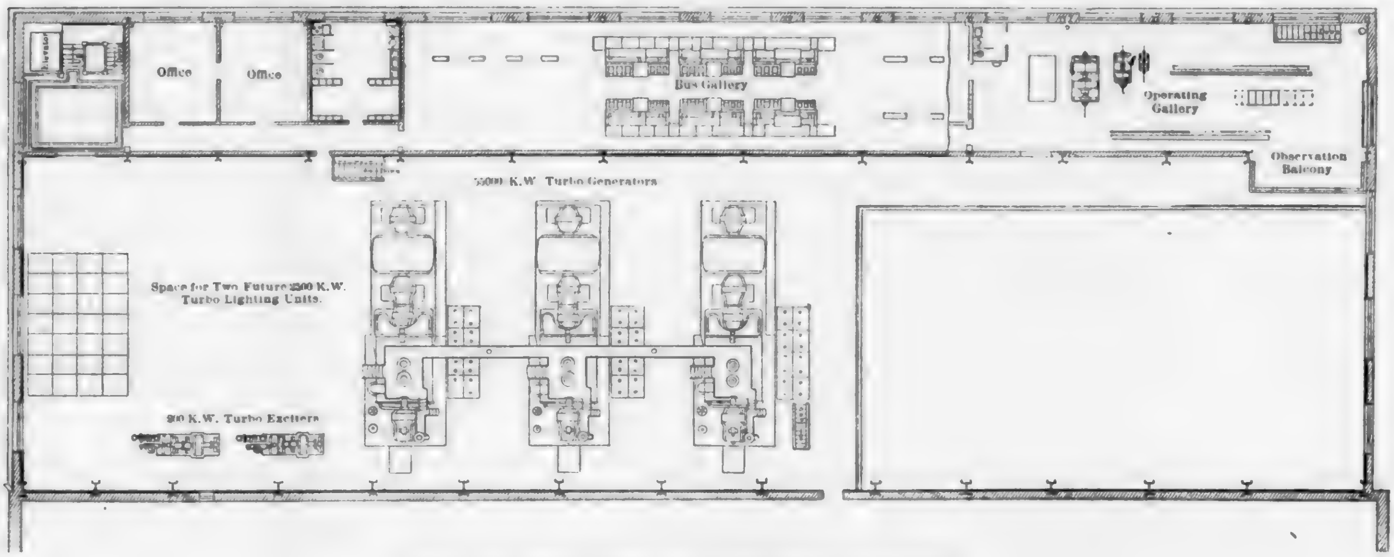
Exhaust Piping.—The exhaust connection between the turbine and condenser is of a square section heavily ribbed cast iron pipe in which is placed a copper expansion joint to prevent strains due to difference in temperature. There is also a provision for open air exhaust through a large 36 in. pipe extending up through the roof and capped with an exhaust header, which becomes operative through a horizontal relief valve operated from the engine room floor.

The dry air vacuum pumps all connect to an 8 in. header above the pumps to which is taken two 6 in. connections from each condenser. This permits any pump or number of pumps to be worked on any condenser. The discharge from these pumps is carried into a common header, which connects to the out board exhaust line.

Exhaust from the other auxiliary machinery is divided into two systems, one receiving the exhaust from the single acting engines which drive the condenser circulating pumps and the other receiving exhaust from all other auxiliary apparatus. The first system leads to the closed feed water heaters and also has a cross connection to the second system which leads to the large open heater previously mentioned.

For returning the water of condensation in the steam pipes to the boilers two Holley gravity return systems are provided. One serving the main or superheated steam pipe and the other the auxiliary steam piping.

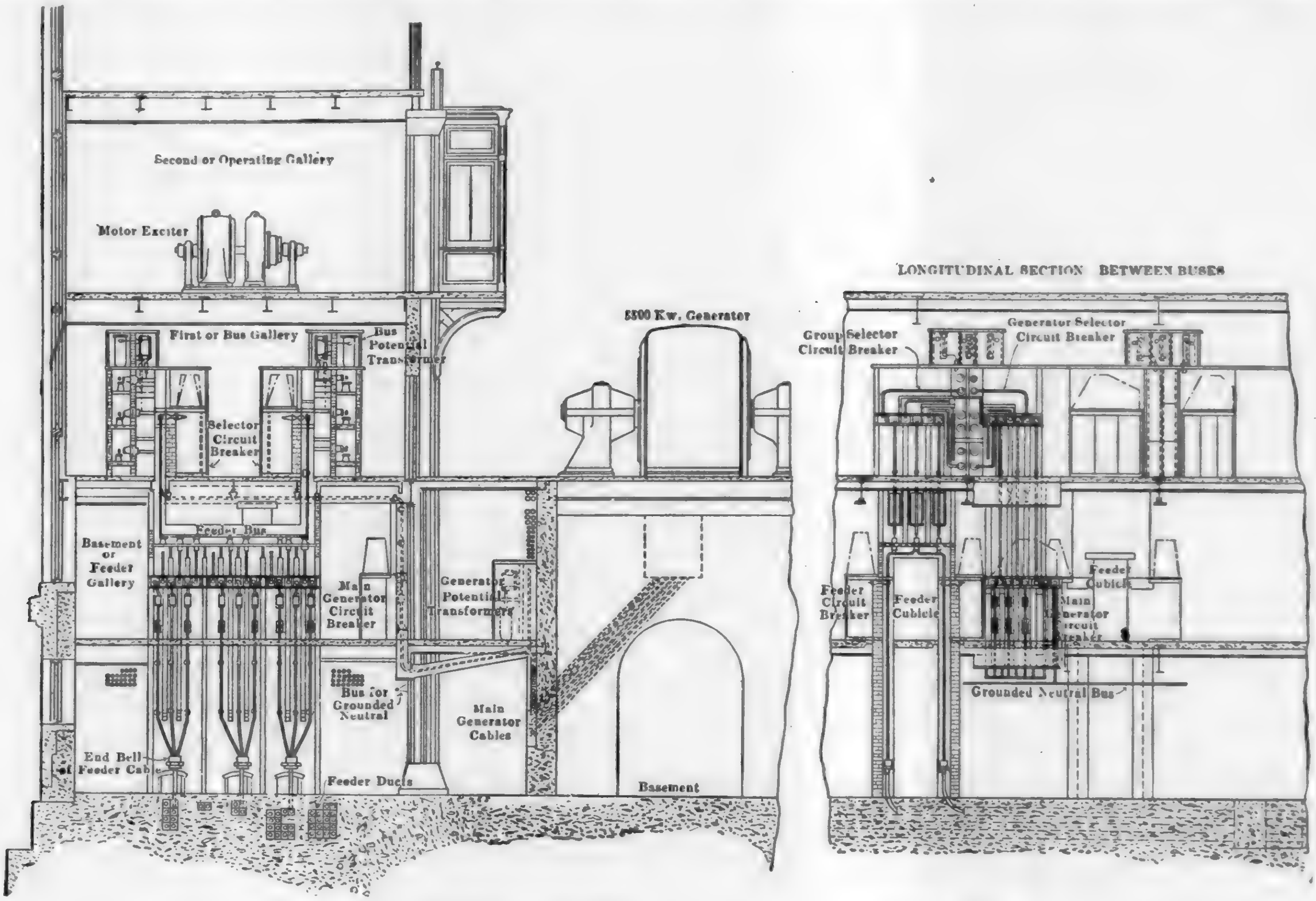
Lubricating Oil Circulation.—There are three systems for distributing lubricating oil. The first is that which distributes the oil to the turbine bearings and includes a storage tank 8 ft. in diameter by 14 ft. 8 ins. deep situated in the boiler house at about the level of the coal bunker room. The oil is distributed by gravity to the turbine bearings. From the bearings it is carried to a filter tank from which it is automatically pumped to the storage tank again. The connections of this system are all of brass pipe. The oil pumping and filtering machinery is located in a two story closed chamber at the east end of the engine room basement. There are about 5,000 gallons of oil in this system and about 90 gals. per min. is circulated through each turbine when in operation. A similar system is used for oiling the crank cases of the Westinghouse engine. Cylinder oil for the lubrication of the cylinders of reciprocating engines is also handled by a similar gravity system, the tank for which is kept filled with fresh oil by means of compressed air.



PLAN OF ENGINE ROOM AND ELECTRICAL GALLERIES.

ELECTRICAL DIVISION.

Generators.—The electrical generators are four-pole revolving field machines of standard Westinghouse construction for turbine drive. They are three-phase alternators, running at 750 r.p.m. delivering current at 11,000 volts and are guaranteed to deliver 289 emperes per terminal. They are star wound with the neutral point of the three machines connected to a common bus, which is permanently grounded through resistance. The stationary armature, enclosed in a large cylindrical yoke of cast iron, consists of a core built up of overlapping punchings of soft steel sheet with the interior surface slotted to receive the winding. Suitable ventilating strips are inserted to form passages for free circulation of air. The coils are wound with copper wire and secured in the slots by retaining wedges of hard fibre. The revolving field is formed out of solid steel discs milled to receive the winding. It is 6 ft. 8¼ ins. in diameter and about 6 ft. long. The field coils are wound with heavy copper straps embedded in



SECTIONS OF ELECTRICAL GALLERIES.—P. N. Y. & L. I. R. R. POWER STATION.

the slots and retained by heavy bronze wedges. Ventilating ducts are provided enabling the revolving field to draw a large supply of air through its interior for the purpose of cooling.

The core is pressed on and keyed to a shaft of nickel steel 19¾ ins. in diameter, through the bearings of which there is a forced circulation of oil. The field is separately excited at 220 volts, current being delivered to the winding through two ring collectors by means of carbon brushes.

EXCITERS.—Three separate sources are provided for exciting the fields, consisting of two steam-driven exciters, one motor-driven exciter and a storage battery. These all give direct current at from 180 to 220 volts.

The steam-driven units consist of turbine sets of a design similar to the main units, running at 1,800 r.p.m. These turbines take steam from either the superheated or saturated steam line and can be exhausted through any of the exhaust systems. The generators are 200 k.w. direct connected machines.

The motor-driven exciter is also a 200 k.w. generator and is driven by a 290 h.p. three-phase 440 volt induction motor. This machine is located in the operating gallery and the motor obtains its current through three 175 k.w. self-cooling transformers located in the basement.

The storage battery is located in the engine room basement and consists of 110 cells, each containing seven plates of the type R chloride accumulators manufactured by the Electric Storage Battery Mfg. Company. The tanks are large enough to ultimately contain 11 plates each. This battery has a charge rate of 366 amperes for one hour and is normally kept floating across the excitation buses. A 12½ k.w. booster driven by a 15 h. p. induction motor is installed to charge the battery if necessary.

ELECTRIC CIRCUITS.—The diagrams of the high and low ten-

(Continued on page 194.)

VIEW IN BUS GALLERY, SHOWING SELECTOR SWITCHES.

(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE.

J. S. BONSALL,
Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT, E. A. AVERILL, } Editors.

MAY, 1906.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union. Remit by Express Money Order, Draft or Post Office Order. Subscription for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn St., Chicago, Ill. Damrell & Upham, 283 Washington St., Boston, Mass. Philip Roeder, 307 North Fourth St., St. Louis, Mo. R. S. Davis & Co., 346 Fifth Ave., Pittsburgh, Pa. Century News Co., 6 Third St., S. Minneapolis, Minn. W. Dawson & Sons, Ltd., Cannon St., Bream's Buildings, London, E. C., England.*

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase of construction.*

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One of the possible advantages of the use of superheating which appeals with special force to the American motive power official is the opportunity to use lower boiler pressure and still obtain equal tractive effort. This was mentioned by Mr. Vaughan in his paper on the subject before the New York Railroad Club as well as before the Master Mechanics Convention last year, when it was stated that while such construction was quite usual in Germany, so far it had not been tried in this country. In view of the largely increased boiler troubles with the increase of pressures from 180 lbs. to 200 or 210 lbs., the idea of being able to return to the lower pressure without loss of efficiency is attractive and makes fully as good an argument for the use of superheaters as a considerable saving of fuel or water does. With a view of determining the facts in this connection the Canadian Pacific Railway, which has had much more experience with superheaters than any other American railway, in building a number of consolidation locomotives at its Angus shops is constructing part of them with 21x28 in. cylinders and 200 lbs. of steam, without superheaters, and part with 22½x28 in. cylinders and 175 lbs. of steam, using the C. P. R. type of superheater.

In an address, before the Traffic Club of Pittsburg, on the subject of ways and means of maintaining a car supply, Mr. L. C. Bihler, the president, stated that "The signs of the time point to a universal gondola as the car of the future." This remark, of course, applies to traffic which may be moved in open cars, and the term "universal gondola" is applied to one with drop doors and also with drop end gates, so that when necessary long material may be loaded in them. The drop end weakens the car, and while it may doubtless be used to very good advantage in some districts, it is doubtful if it will ever be very generally adopted. The hopper bottom gondola car with fixed ends seems to have become a very popular type, especially in the Pittsburg and similar districts where a great deal of coal and iron ore are handled.. A number of designs have recently appeared in which this type of car is equipped with drop doors, which, when closed, are flush with the floor. Some of these designs also have provision for discharging almost the entire load by gravity, and unquestionably this type of car, which can be used for almost any commodity which may be moved in open cars, will be a very popular one and will probably come into more general use than the car with drop end gates.

How can a foreman be expected to greatly improve the efficiency of the shop if he is not thoroughly acquainted with the value of the material he is using, as well as the cost of doing the work. To intelligently decide as to the wisdom of repairing or scrapping an article, or as to the choice of material for a certain purpose, he must be familiar with the cost of material, and yet on how many roads do we find the foremen unfamiliar with the costs of material and often making expensive mistakes, which they would not do if they were better posted. Can you imagine this state of affairs existing in an up-to-date manufacturing establishment? Several of the more progressive railroad shop managements appreciate the importance of this question, and on one large system the cost of each article is marked on the bin or convenient to the place in which it is kept in the storehouse, and the storekeeper marks the price of each article on a duplicate of the order slip, which is returned with the material. If there is any question in the mind of the foreman as to the choice of material, and often either one of two materials varying widely in price will give equal satisfaction, or if he is in doubt as to the wisdom of repairing or scrapping an article, he can readily get complete information as to costs. It may cost something to keep such a system in operation, but the saving to be effected undoubtedly warrants its use.

In this issue is shown the large power house recently finished by the Pennsylvania, New York & Long Island Railroad Company at Long Island City. This is one of five large power

plants which within the next few years will furnish electric current to handle every passenger train at present drawn by steam locomotives on the island of Manhattan, in addition to many new trains which will enter by the several tunnels now in course of construction. It is one of two large plants which will furnish power to the trains of the Pennsylvania Railroad Company running in the tunnels from Jersey City under New York to Long Island City, the other to be located in Jersey City; and it will also ultimately move all the trains in the suburban zone of the Long Island Railroad, part of which are at present running by electricity, obtaining current from this plant. In fact, the completion of this power house in advance of the remainder of the work on the Pennsylvania's extension was for the purpose of supplying the requirements of the Long Island Railroad Company. The extensive electrification plans of the three large railroad companies entering New York City which, with the attending terminal improvements, it has been stated, will cost more than the building of the Panama Canal, are familiar to most railroad men, and the completion of this, the first finished section of the work, is of especial interest. Practically all other parts are well under way, the two power plants and several sub-stations of the New York Central are approaching completion, the plant of the New York, New Haven & Hartford is well started, and the work on the tunnels and terminals of the Pennsylvania, as well as the line and new terminal of the New York Central, is progressing nicely.

In the April issue we presented a new design of locomotive boiler which, as a correspondent whose communication is given in this issue draws attention to, is practically the incorporation of the main features of the successful Yarrow type of marine boiler into a locomotive firebox while still retaining the general arrangement of the present fire-box. As pointed out in the communication, many of the objectionable features of the Yarrow design have been eliminated and new arrangements included which should tend to make it a better steam generator than a marine boiler of the same size.

It is pretty generally believed that a square foot of firebox heating surface is at least five times as valuable for evaporating purposes as the same average area in the flues, in which case the addition of over 500 sq. ft. in the very hottest part of the firebox will result in a large increase in the capacity of the boiler. However, the value of heating surface depends very largely on the rate of the passage of water over it, and if proper provision is not made to get the water to and from all points, its value decreases very rapidly. This feature has been clearly recognized by Mr. Riegel, and an arrangement is made which will not only provide sufficient circulation through the tubes, but will improve the movement across a greater part of the side sheets. It is evident from an inspection of the drawings of this boiler that the flow will be from the top of the baffle plate placed 30 ins. ahead of the flue sheet, downward and backward over the side sheets, up the back head and through the water tubes. This gives a direct circuit which will have but little interference from eddy currents, except on the upper part of the side sheets where there is room for the passage of two currents. Thus with a larger amount of heating surface located to the best advantage and provision made for free circulation, it would appear as if a boiler of this design would give the much desired increase of boiler capacity without any great addition of weight or clearance.

PROMOTION IN RAILROAD SERVICE.

While it may be necessary to occasionally inject "new blood" into a high official position on a railroad it ought, theoretically at least, never to be necessary to go outside of the service to fill any subordinate position, and the day is likely to come when railroads will adopt the policy of advancing their own men and put a stop to this too prevalent system of going outside of their own personnel for department heads and department subordinate officials. On some roads the policy of advancement of employees has already become law, and it is hardly necessary to say that such roads retain their men and lose very few even of the best of them. This question of advancement of subordinates reaches the fundamentals of organization and to carry out such a plan properly requires improved methods of recruiting and methods of keeping track of the good men, which will lead to the discovery of ability. A scheme of advancement from the ranks necessarily includes a good system of apprenticeship, and places a premium upon the finding of ability among the "men" to be foremen and other officials of the grade of foremen.

For most railroads it would be a hopeless task to inaugurate progressive promotion not because of the lack of material for promotion, but because of the lack of a system which makes it possible for ability to discover itself. As long as the railroads look to the colleges for material for officers the case is hopeless. It is not that good officers are not made from college men and no disparagement to the college men is intended or implied, but it is necessary that a premium should be placed upon coming up through the ranks, whether the material for promotion is the college man or not. Some one has said, "Any fool may go through college, but it takes a man to come up through the ranks." The ideal way to secure the necessary educated man is to educate the rank and file, and by a careful, systematic sifting, educate a few with a view of becoming officers after they make good.

The responsibilities of the present railroad officer requires a knowledge and ability which are generally the result of long experience, and the railroads cannot look for the supply of officers from any school except that of experience. A thorough knowledge of details is the primary requisite upon which to build with experience and education. It is clear that the railroads must look to their ranks for officers both high and low if the standard of railway service is to be lifted to its proper height.

To meet the emergencies of the future it is necessary to provide a surplus of competent employees and subordinate officials equal to any possible demand, and, this may be done through recruiting and apprenticeship, whether it be in the office, in the shop, or elsewhere. To secure such a body of men as material for future promotion, ambition must be cultivated, accompanied by a surety of advancement as a result of long continued conscientious effort. This feeling of ambition can be completely killed by turning too often to men outside the service when important positions are to be filled.

In the army outsiders are not taken in to fill vacant positions and to suggest such a possibility in military matters seems absurd. To obtain good men it is necessary that the service should be attractive and this cannot be accomplished if ambition is not stimulated. Something besides mere permanence of employment is needed. A surety of something better in the future is an absolute necessity. Bright and intelligent young men will turn away from railroad service unless they can see advancement held out as a reward. The keynote for the right sort of an organization is encouragement, and he who complains that of his thousands of employees there is not one capable of promotion to fill any possible vacancy only reveals his incompetence. It is not possible for every one to be promoted, but an officer who disregards his own staff and rank and file and offers an attractive position to an outsider loses an opportunity to promote that loyalty and voluntary endeavor among his subordinates, which are necessary to his own success, and which cannot safely be violated. Promotion always reveals some soreheads, but it is better to have a few of these rather than to deaden the whole mass of employees.

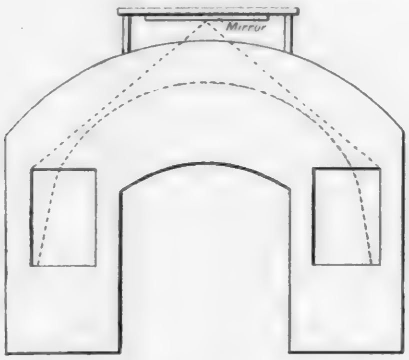
Progress in a large organization is necessarily slow, and it is better that it should be slow as slow growth is most likely to be permanent. Railroads which are to stand in the lead in the long run are those upon which this principle of promotion within the service is appreciated and is made a part of the written and unwritten law.

COMMUNICATIONS.

SAFETY DEVICE IN ENGINE CAB.

To the Editor:

Having read recently of several wrecks on our railroads caused by the engineer being hurt or killed while on the engine, without the knowledge of the fireman, I enclose herewith a sketch of a



device, whereby the fireman and engineer can see each other, while on opposite sides of the cab.

As shown, a mirror is placed in the roof of the cab, enabling the men to see over the boiler head, even when same nearly touches the roof. A polished steel plate would serve the purpose equally well.

Hugh G. Boutell.

CONVENIENT METHOD OF VALVE SETTING.

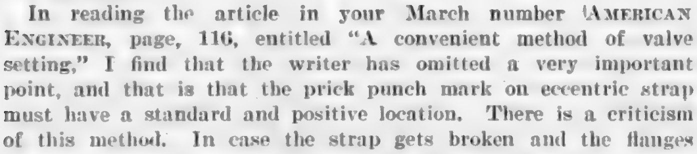
To the Editor:

In reading the article in your March number (American Engineer, page, 116, entitled "A convenient method of valve setting," I find that the writer has omitted a very important point, and that is that the prick punch mark on eccentric strap must have a standard and positive location. There is a criticism of this method. In case the strap gets broken and the flanges are broken you lose your point and it is impossible to adjust your blade on a new strap without running the valve over. For several years I have used a "Hook" tram for this work and it overcomes the above. The tram is constructed with a hook on one end and the ordinary square bend on the other end. When it is desired to change a blade from one strap to another, place the hook end inside the strap on the wearing surface, and scribe a line on the blade before loosening any bolts. When blade is fastened to new strap set it so that tram point comes on the mark, and you have the correct length of blades as you have the positive length from wearing surface of strap.

Your truly,

New Haven, Conn. A. L. Roberts.

To the Editor:—In the March issue of your journal I noticed an article entitled "Convenient Method of Valve Setting." This method would be satisfactory only in case the wearing surface of the eccentric strap never changed or the blades had never been altered in the roundhouse previous to the breaking of the strap. Now, it is very evident, the former changes in proportion to the length of time the engine has run and very frequently the blades



are altered. In my experience I have found that an engine is not out of the back shop long before the roundhouse men find it necessary to make some changes in the blades to keep the engine square. The valves might have been perfectly square when leaving the shop, but after being broken in and running a few trips would show out.

In my roundhouse experience I have had a good many broken straps to change, and the best tram I have ever seen, for the purpose of setting the blade at the right length, is the one shown in the sketch I enclose. The old strap and blade are taken down together and point "A" of the tram placed on the wearing surface of the strap about in line with the centre of the blade; with point "B" scribe a point on the blade. Disconnect the blade from the broken strap and substitute the new one. Place point "A" of the tram on the wearing surface of the new strap in line with the centre of the blade and move the blade until point "B" coincides with the mark made by the tram before. Secure the blade in that position and you can be sure it is exactly the same length as before. I have never had a strap to change yet where I could not use this tram. It does not need to be a standard length, as any convenient length will answer the purpose. F. A. Dailey.

Sedalia, Mo.

RIEGEL WATER TUBE BOILER.

To the Editor:

Referring to the Riegel design of locomotive boiler shown on page 136 in your April issue, it seems to me that the main idea admirably provides exactly what we have been requiring with the wide firebox, and that any adverse criticism would be more justly directed to an indisposition to at least make trial of it than to design itself. Aside from the simple and practical manner in which the necessary additional firebox heating surface is supplied, I am considerably impressed with the idea of converting the sides of the mud ring into easily opened mud drums. This also enables the rapid interior incrustation of the water tubes to be easily taken care of by ordinary turbine cleaners. Also, these tubes will apparently provide that increased rapidity of circulation, whose lack in the present designs is so much deplored. In this connection, however, I am impelled to oppose the designer's idea of placing a circulation baffling sheet in ahead of the tube sheet, in fact, I believe such an obstacle would ruin the boiler. In view of the large amount of water which would have to flow to the water pockets it would seem as if a wider throat would be desirable. It also occurs to me that the disturbance of the wagon-top surface could be avoided, while, yet providing the necessary support to both the wagon-top and the staying cylinder. The brick arch seems a little awkward—in line with recent Northern Pacific experience, possibly the addition of a combustion chamber would enable a nicer arch arrangement.

As stated, however, these objections are minor details, which could be left to individual preferences, the main idea is the thing and it looks to the writer as if Mr. Riegel has hit what we have been looking for.

Western.

To the Editor:

My experience with Yarrow type water-tube boilers in marine service and locomotive type boilers in railroad service, indicates that the design of water-tube locomotive boiler shown in your April issue has the good features and lacks many of the bad features of both types. The water-tube portion is precisely the idea of the Yarrow type.

This type of boiler for marine service is usually made with 1-in. tubes placed in five ranks and very close together, their heating surface being far greater than normal conditions require. This is necessary because the only way to remove an inside failed tube is to cut out and plug good tubes till the split one is reached, working from the grate side. Most water-tube boilers are subject to this destruction of heating surface. The water pocket mud-ring of the Riegel boiler provides access to the lower ends of the tubes, which is an impossibility in regular Yarrow boilers, and will allow tubes to be tightened or replaced instead of plugged. The staying ribs in the mud-ring need to be mostly holes, to allow for a very high circulation of water to supply the tubes and prevent burning them.

Much trouble is given by soot and clinkers forming among the close Yarrow tubes. This is so great that a steam jet blown every watch, and a crooked saw to cut clinkers out at every shutdown are necessary to keep the boiler in service, these troubles will be avoided by the large tubes and wider spacing in the Riegel boiler. The advantage of the original idea of the Yarrow type, i. e., a straight tube, is herein well exemplified.

The staying cylinder placed above the crown sheet should act as a good baffle, keeping water well away from the main current of steam which will pass from the tubes to the dome. There is a possibility, however, that it will act as a pipe conveyer, and carry all the water onward with the steam. Yarrow boilers usually

prime badly at lower power, and give no trouble when forced hard. The brick arch ought to be a wall at the front of the water-tubes, forcing most of the gases among them. The method of supporting the inclined form of arch shown in the illustration is not clear.

I have only condemnation for the cold water dam, placed ahead of the flue sheet. The lower flues will be continually chilled and leak incessantly. Better put the water supply in such a way as to help the circulation, not hinder it. With that removed the circulation in this boiler should prove to be much better than any other locomotive boiler I have ever seen designed. Expansion should cause little or no trouble, for the construction is very simple and very accessible.

I hope we shall see a boiler of this type tried, for it appears to be a long step forward, and in a direction where improvement is much needed

Paul R. Brooks.

New York.

GENERAL FOREMEN'S CONVENTION.

To the Editor:

A study of the program of the International Railway General Foremen's Association convention (see page 196 of this issue), to be held at St. Louis the early part of May, suggests that the value of the association could possibly be very greatly increased if more of the subjects to be considered were more intimately concerned with the work of the foremen. As the association is made up of superintendents of shops, general foremen, division foremen, machine foremen, roundhouse foremen and their assistants, the consideration of such questions as electricity versus steam as a motive power, electricity versus oil for headlights and the pooling of engines seems to be a little out of place, especially when we consider the many serious problems which confront the shop and roundhouse foreman in their efforts to secure greater efficiency and increased output.

The progress which has been made in shop equipment, operation and organization during the past few years, the marked increase in the size and capacity of locomotives and cars, and the fact that the larger locomotives and the changes in the method of operating trains has made it necessary to radically change roundhouse design, operation, organization and equipment would suggest that the time of the convention, which will necessarily be limited, could be much more profitably spent in discussing subjects concerned with these features rather than subjects which come outside the jurisdiction of the foremen, and properly come within the scope of other organizations.

There is hardly a more important question before the railroad mechanical departments to-day than that of shop organization and operation. Magnificent and extensive shops have been built and equipped with the latest design of machinery, and, when placed in operation have made a comparatively poor showing, and, then came the realization that the larger plant required a different and more perfect kind of organization than the older and smaller ones. The master mechanic who has under his jurisdiction a large shop in connection with his work over a division of 150 miles or so, is fast disappearing, and in his place we find a shop superintendent who devotes his entire time to the shop and reports directly to the head of the motive power department, and a master mechanic who looks after the division and has nothing to do with the shop. It is surprising that some phase of this problem of organization does not find a place on the program.

Then there are the all important subjects of piece work; the individual effort method of profit sharing and the premium plan. The foremen should consider these systems and the method of their introduction. It is all important that he be perfectly familiar with them, for, while in many cases it may not be in his power to decide upon their introduction, yet their success after introduction is largely dependent upon him.

There are many other important questions which might be considered such, for instance, as special jigs, mandrels, tools, etc., to improve the shop production; special tools for roundhouse work, shop schedules, improved methods of handling work, the relation of the shop foremen to the store department, the care of belts, use of high-speed steel, the requirements of various machine tools as regards variable speed, and a hundred others more or less important.

This communication is not intended as a criticism but rather a suggestion. The association can readily make itself exceedingly valuable, and, indeed, is doing remarkably well considering the short time it has been in existence. It should be loyally supported by all those who are eligible to membership

A. Foreman.

IMPROVING RAILROAD SHOP EFFICIENCY.

By Charles Coleman.*

Reduction in the cost of repairs without impairing the efficiency of the locomotive will be considered from the shop viewpoint only, and this will, of course, not include outside conditions, which cause excessive repairs, such as bad water, overloading, pooling, double-heading, delay on sidetracks, and, worst of all, the neglect of running repairs.

In order to successfully reduce the cost of repairs it is important that those in charge should be thoroughly familiar with the cost of making the repairs and the cost of material entering into them, and this data, if possible, should be known for each operation. To this end duplicate work should be done on shop orders and costs should be furnished as quickly as possible, so that the output of the machine tools and the cost of manufacture may be closely followed and a check can be kept on the storekeeping department in charging out material. Every facility should be given those interested to obtain information concerning costs. Where the material is manufactured at both the main and the smaller shops, price lists for doing the work at the main shops should be sent out frequently to the other shops for comparison.

Where manufacturing is done at different points on the road it is advisable to specify certain kinds of work which are to be done at each point in order to save the duplicating of expensive machinery and small tools, and also because the manufacture of articles in large quantities makes it possible to give more thought to the making of special tools and jigs and the cost of manufacture can thus be materially decreased. It also makes posssible the use of turret and automatic machinery where their cost would be prohibitive if the same class of work was done in each of the shops and the machines were in use only a small portion of the time. New machinery should never be purchased unless it can be clearly shown that the improved output will more than offset the interest on the capital invested.

The importance of standardizing work and the use of jigs cannot be overestimated. This applies to the boiler shop and other work as well as to the machine shop. There is no reason why holes in the flue, door and side sheets of the firebox should not be made interchangeable as easily as are guides or crossheads. The use of jigs saves time both in the laying out and machining, and in many cases there will be a considerable saving in material. The judicious use of templates and jigs makes possible a saving of one-half the time in laying out in a boiler shop and more accurate results are obtained.

So much has been said concerning rapid production and high-speed steel that little can be added except that it is important that the output of the smaller machines be not neglected while records are being made on the larger tools, such as wheel lathes, milling machines, etc. Much can be gained by improving the chucking and setting facilities, and 15 minutes saved in this way is as valuable as that much time saved in tearing off the material with high-speed tools and it results in less damage to the machinery.

The unnecessary handling of material is often lost sight of and care should be taken in locating new machinery to require a minimum amount of handling of material. It is sometimes good policy to move a machine already placed, in order to do away with unnecessary trucking or handling. A piece of iron cannot even be picked off the floor without adding to its cost.

Co-operation and good feeling between the different foremen is absolutely esssential, and this is also true in regard to the men. All promises should be kept and contracts should be lived up to. As a rule there need be no friction and labor trouble if the men are treated fairly. The old adage "like master like man" still holds good.

Suggestions for the good of the service should be given respectful attention, and if adopted the party making them should at least be given credit. Opportunity should be given

*General Foreman C. & N. W. Ry. shops, Winona, Minn.

the foremen to visit other shops and see what other people are doing.

Co-operation between the mechanical and the storekeeping department and advising with the storekeeper in regard to present and anticipated future needs will result in the saving of money for the company and avoid many vexatious delays. Notice should be given to the shop superintendent or master mechanic of the engines which are expected to come in during the next 60 or 90 days, and as far as possible a memorandum of the new material which will be required. In this way the amount of stock necessary to be carried can be reduced to a minimum. It is also advisable for a capable representative of the mechanical department to go through the stock at intervals with the storekeeper and cut out all obsolete material.

The question of patterns requires close study in order to avoid carrying thousands of dollars worth of extra material in the storehouse and also of having to remove an unreasonable amount of stock in the machines. A certain road with 1,400 engines has five eccentric patterns, while another road with 350 engines has about 25 eccentric patterns.

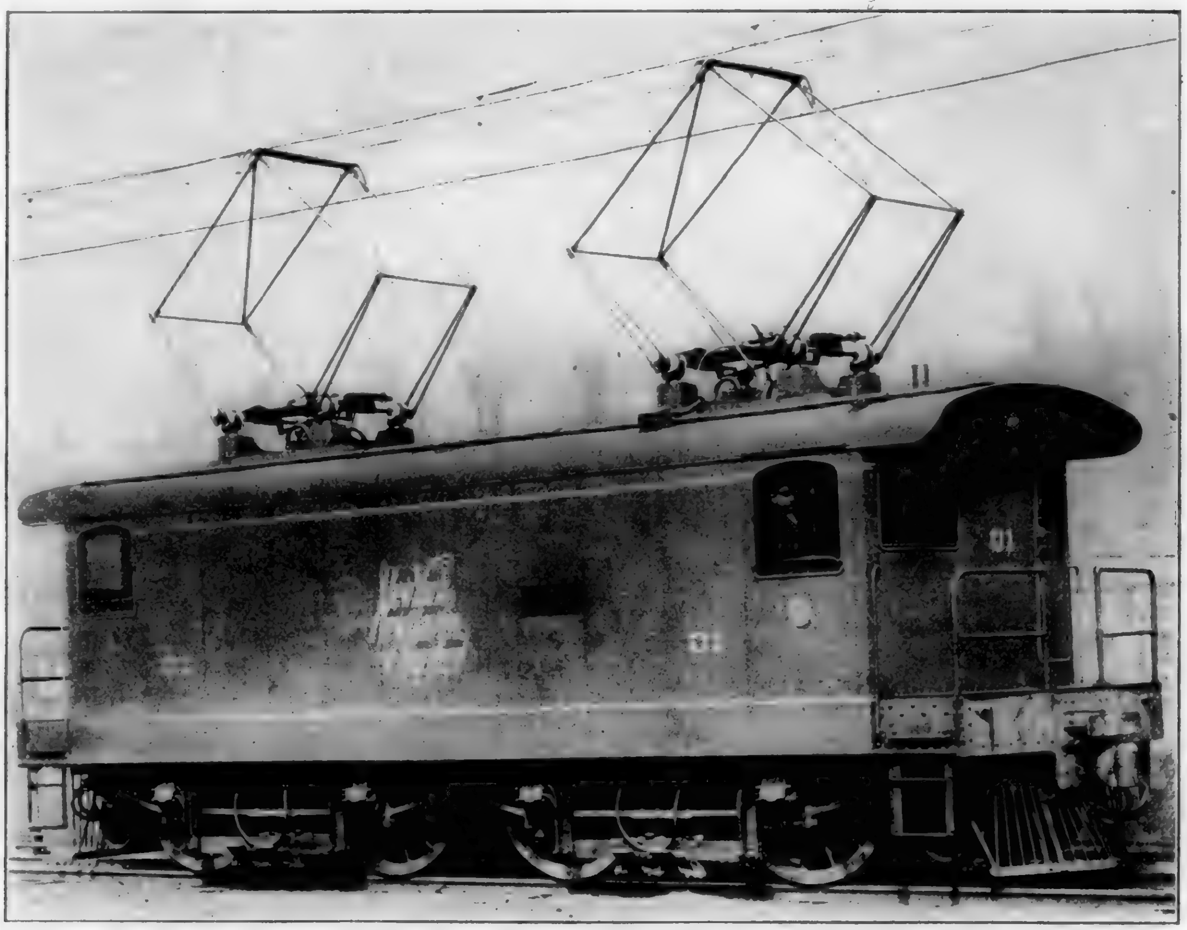
A good idea in use on one large system is that whenever a tool is gotten out and is a pronounced success, blue prints are sent to headquarters and it is incorporated in a blue print book of special tools and sent to all points on the system.

A thorough examination should be made of all engines coming to the shop for repairs, and no engine should be taken into the shop until all necessary material is on hand. In order to reduce the average pit hours per engine to a minimum those in charge should have the necessary authority, sufficient superintendence should be allowed, and the shop force should be properly organized, and, of course, in addition the shop should be fairly equipped for doing the work.

SINGLE PHASE ELECTRIC LOCOMOTIVE.

New York, New Haven & Hartford R. R.

The present plans of the New York, New Haven & Hartford Railroad Company contemplate the electrical operation of its main line between New York City and Stamford, Conn., a distance of over 33 miles. That portion of the railroad which lies between the Grand Central Station and Woodlawn, N. Y., utilizes the tracks of the New York Central & Hudson River Railroad, and constitutes a portion of the electrical zone of that company. On this section of about 13 miles the New Haven trains will be operated by the direct current third rail system there installed, but between Woodlawn and Stamford the road will be equipped to use single phase alternating current, and the trains will be operated by electric locomotives which take current from an overhead trolley line.

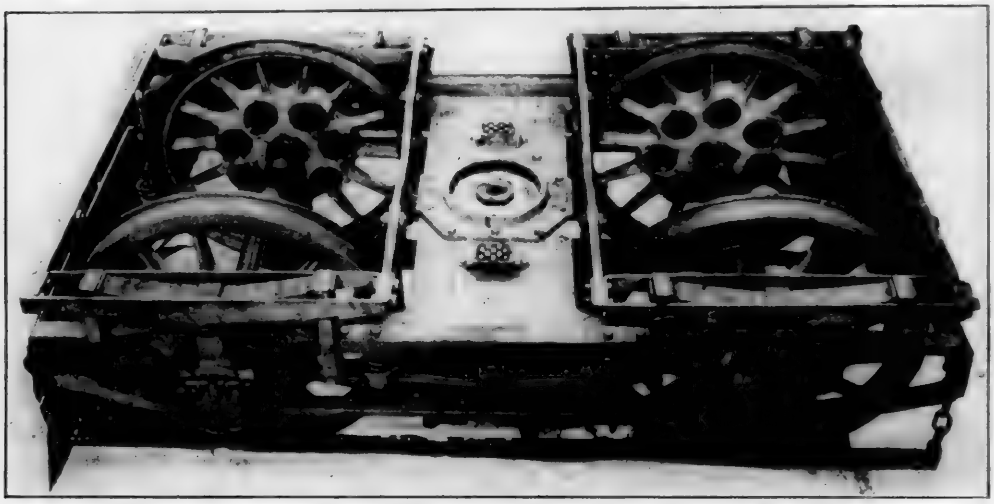


SINGLE PHASE ELECTRIC LOCOMOTIVE.—NEW YORK, NEW HAVEN & HARTFORD R. R.

The locomotives for use under these conditions must necessarily be capable of operation both by alternating and direct current, and be equipped with collectors for taking current from a trolley or third rail, either with an under contact, as will be used on the New York Central Lines, or an over contact, as will be used in certain small stretches of the New Haven Railroad. Locomotives fulfilling these requirements and capable of handling a 200-ton train in local service on a schedule speed of 26 miles per hour with stops averaging about two miles apart, or a 250-ton train on through service at a maximum speed of 60 miles per hour, are being built by the Westinghouse Electric & Manufacturing Company. When it is desired to handle heavier trains than mentioned above, two or more locomotives can be connected together and operated as one unit. Each locomotive measures 36 ft. 4 ins. over bumpers, and weighs approximately 85 tons. They are, as can be seen in the illustration, mounted on two trucks, each having four 62-in. driving wheels.

The frame, trucks and cab of the locomotive were built by the Baldwin Locomotive Company, and the electrical equipment complete by the Westinghouse Company.

FRAMES.—The main frame of the locomotive through which the drawbar pull is transmitted to the trucks is of very strong and stiff construction, being built up of standard section steel members thoroughly braced and reinforced. It is set low in order to get as near a direct pull from the coupler to the truck as possible. The side sills are heavy channels placed outside the wheels, and are rigidly tied together by heavy end sills and transoms, also of channels. The whole structure is braced by the steel floor and heavy gusset plates wherever needed. The pull to the frame is transmitted from the trucks through center pins.



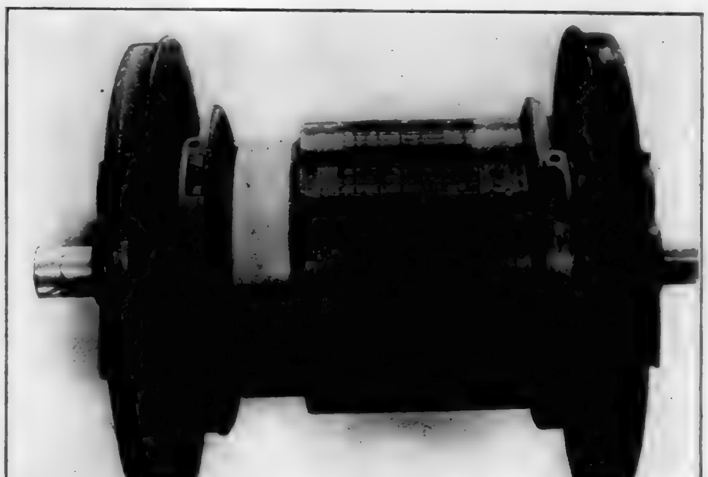
SINGLE PHASE ELECTRIC LOCOMOTIVE.—VIEW OF DRIVING TRUCK, WITH MOTORS REMOVED.

The cab is formed of steel plates mounted on a framework of Z bars, and has windows and doors, as shown in the illustration.

TRUCKS.—Each of the trucks, as above mentioned, is mounted on two pairs of 62-in. driving wheels with outside journals. Side frames of forged steel with pedestals for the journal boxes are placed outside the driving wheels, and connected together at the center by a very heavy pressed steel bolster, which carries the center plate. These bolsters are made wide and deep, and have an extra width of bearing at the side frames, to which they are securely fastened. The ends of the side frames, which extend beyond the wheels, are cross connected by steel plates, thus making a rigid and strong truck frame of simple design. The bolsters are 30 ins. wide at the center plate and nearly 60 ins. wide at the side frames. The pedestals are provided with shoes and wedges, and carry a modified design of M. C. B. journal boxes. The centre plate is 18 ins. in diameter, and special provision is made for lubricating both pin and bearing. The weight is carried from the frame to the wheels by semi-elliptical springs on top of the frame over each journal box, which are equalized together at the inner ends by a cast-steel equalizing bar, which has coil springs at either end to assist in maintaining the equilibrium.

Each truck carries two motors of the compensating gearless type, wound for 235 volts alternating and 275-300 volts direct, which have a nominal rated output of 250 h.p. each, therefore giving the locomotive a total hourly rating of 1,000 h.p., or a continuous operating capacity of 800 h.p. The motors are carried on a quill which surrounds the driving axle, but does not bear upon it. This quill, on which the armature is carried direct and the field through bearings, has 5/8-in. clearance around the axle, and is connected to each driving wheel by seven pins projecting from the flange of the quill on either end, which fit into corresponding pockets formed in the hub of the wheel. These pins do not fit the pockets in the wheel center, there being a clearance left for the insertion of helical steel springs, which are wound with their turns progressively eccentric. These springs fit between two steel bushings, one of which slips over the pin on the quill and the other fits inside of the pocket in the wheel center. These springs are under compression, both longitudinally and horizontally, so that at all times they fill the pockets in the wheel but permit a lateral motion. By this method all of the power from the motor is transmitted to the wheels through a yielding connection. The weight of the motor is carried on a frame, which passes around the wheels and over the side frames, and rests directly upon the journal box spring bearing, as is clearly shown in the illustration of the truck. Each frame carries four long bolts, which receive the weight of the motor through a heavy coil spring at their lower ends. The torque of the motor is resisted by heavy parallel rods, which anchor the motor frame to the truck above and below the axle, and permit a vertical or side motion of the motor, but prevent excessive strains from coming onto the driving springs. If these springs are compressed more than 1/4 in. by the heavy centrifugal force exerted by the motors when rounding curves the force is taken up by noses on the motor frame, which fit into corresponding recesses in the cross ties between the side frames of the locomotive.

This method of motor suspension removes all dead weight from the axle and makes all parts of the locomotive, with the exception of the driving wheels, axles and journal boxes, supported by springs. The motors are arranged for ventilation by a forced circulation of air, which enters under pressure, is distributed throughout the motor and escapes through perforated covers. This air is taken from the inside of the cab and forced through conduits in the frame and conducted to openings in the motor casing by flexible connections. This forced ventilation has the advantage of not only keeping the motor cool, but also prevents any dust or dirt collecting on the motor parts, since the circulation is always outward.

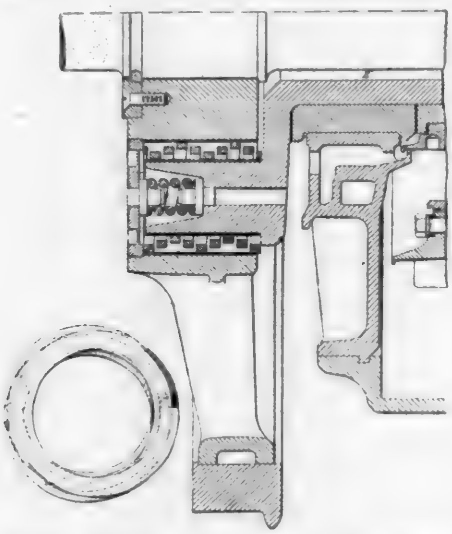


SINGLE PHASE ELECTRIC LOCOMOTIVE.—VIEW OF DRIVER WHEELS, WITH ARMATURE ATTACHED.

CURRENT COLLECTION.—The location of the shoes for collecting current from the third rail shows clearly in the illustration, as does also the pantograph arrangement for collecting the alternating current from the trolley wire. These collectors, of which there are two on each locomotive, are of the bow type, and each has a capacity sufficient to carry the total current required by the locomotive under average conditions.

They are pneumatically operated, and can be raised and lowered by the driver from the inside of the cab.

CONTROL.—The current is brought in from the trolley at 11,000 volts to the auto transformers, the secondary windings of which are tapped at six different points giving six alternating current voltages, or running points. There are also a small number of midway steps, which are used only in passing between working notches on the controller. Thus in operating on the alternating current system no resistance is introduced except a small amount constituting a preventative device to diminish the short circuiting effect when changing from one transformer contact to another. The current is carried through the proper safety devices directly from the controller to the motors, which are connected in parallel. For operating on direct current the motors are connected in the ordinary series parallel manner through resistance. A new feature in this control has been introduced, permitting several efficient running points to be obtained between the point of disconnecting the series connection and going into multiple as it is ordinarily arranged, by the shunting of the fields. This can be done on this type of motor without impairment of commutation.



SECTION SHOWING ARMATURE CONNECTION TO DRIVING WHEEL.

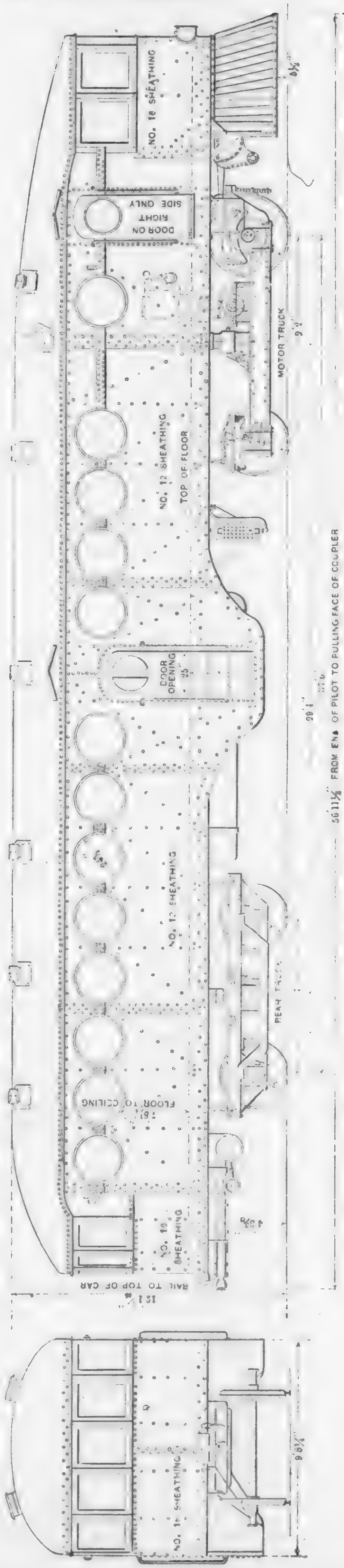
Two auto transformers are placed in each locomotive, which are connected in parallel across the high voltage, but have the low voltage side of each connected to a different pair of motors through a separate control. The main controllers are of the electro pneumatic unit switch type, operated from a master controller at each end of the cab. This system is arranged for multiple unit service, so that two or more locomotives can be coupled and handled by a single driver.

The master controller is of the drum type, and is operated by a horizontal lever, which moves through an arc of about 60 deg., with notches and latch wheel to define the different positions. The reversing is accomplished by a separate handle which interlocks with the main lever.

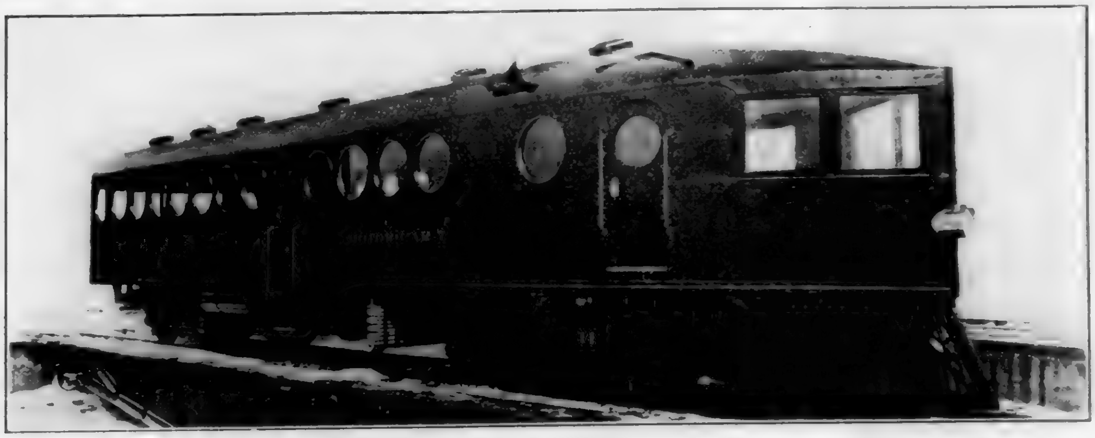
There is also included in the equipment two air compressors driven by motors, which can be operated on either alternating or direct current, for furnishing air for braking power; two blowers, driven by smaller motors, which furnish the air to the transformers, motors and rheostats, and a steam generator for supplying heat to the railway coaches. Also a complete Westinghouse air brake equipment and signal apparatus, automatic bell ringers, air whistles, sanding apparatus, etc.

Thirty-five of these locomotives are being built, the first one of which has been given a very thorough test under all operating conditions, and has shown itself capable of accelerating a 200-ton train at a rate of one-half mile per hour per second, and has been operated on an unfavorable track at speeds of 60 miles per hour.

RAILROAD CLUB AIDS SAN FRANCISCO.—At the April meeting of the New York Railroad Club $1,000 was donated from the club treasury for the relief of suffering in San Francisco.



ELEVATIONS OF GASOLINE MOTOR CAR NO. 7.—UNION PACIFIC R. R. CO.



GASOLINE MOTOR CAR NO. 7.—UNION PACIFIC R. R. CO.

GASOLINE MOTOR CAR NO. 7.

UNION PACIFIC RAILROAD.

Since finishing motor car No. 2, which was illustrated and described in this journal November, 1905, page 420, the Union Pacific Railroad Company has built five more cars on the same general designs, four of which are in regular service.

Motor car No. 2 is at present in service between Kearney and Callaway, Neb., making a round trip of 130 miles daily except Sunday. Car No. 3, which differs from No. 2 only in that it has a baggage compartment, is in service between Houston and Galveston, Texas, on the Southern Pacific lines. Car No. 4, a practical duplicate of No. 3 in general design, is on the lines of the Oregon Railroad & Navigation Company. Car No. 5, which is similar to No. 2, is being operated out of Los Angeles, Cal., and Car No. 6 is being run between Lawrence and Leavenworth, Kan. It draws a trailer, and makes a round trip of 68 miles daily except Sunday.

Motor car No. 7, the latest car to be built, which is illustrated herewith, is of somewhat different design, although in size and weight it is nearly the same as No. 2. The changes consist principally in the use of a side door in the center of the car and of round windows in place of square ones.

The construction of the body to allow the doors to be put in the center of the sides has been very carefully worked out, and has resulted in no loss of strength. The side sills are dropped down below the door sill, and a patented steel framing has been incorporated, which, in connection with slightly heavier steel casing, gives the full strength and stiffness desired. The thicker steel side plates used throughout make this car considerably stronger than its predecessors.

The roof of the previous cars was 15 ins. lower than that of an ordinary passenger coach, and that of No. 7 is still 9 ins. lower, making it 2 ft. below a coach roof. Notwithstanding this lower roof, the ventilation is excellent, being fully equal to the former cars.

The use of the round windows has allowed the elimination of large wooden side posts in this car, which gives an increase of 8 ins. in the interior width. These windows are tight fitting, and are dust and weather proof. They are placed so close together that the interior is extremely well lighted.

Built-up veneered wooden seats are used with a semi-circular seat at the rear. The seating capacity is 75. The interior is finished in English oak.

The motor truck, which carries the 100-h.p., 6-cylinder gasoline engine direct, has a wheel base of 9 ft. 2 ins., and does not have the wheels equalized together as is usual. The engine is set just ahead of the bolster, and connects to the front pair of wheels, which are considerably larger than the rear pair, through a chain from the axle. The engine is built after special railroad patterns, and has a "make and break" spark ignition, with a primary battery to start on and a magneto for regular running service. The cylinders are 8 x 10 ins.; of the upright type, placed at right angles to center line of car. The six cylinders are arranged and connected up in opposed sets of three cylinders, resulting in three power-giving pulsations at each revolution of crankshaft. Compressed air is used for starting the engine, and a synchronizer is used in the changing of speeds.

The car is equipped with direct air brake system, with braking power on all wheels. Attached to the crankshaft is an air pump, which supplies and maintains 100 lbs. air pressure in two reservoirs of 13 cu. ft. each. Numerous tests on Car No. 2 at a speed of 20 miles per hour have shown that the car stops in 112 to 115 ft., without inconvenience to passengers. In addition to the air brake, the car is also equipped with a ratchet lever hand brake.

After running around Omaha yards and vicinity for the purpose of limbering up machinery, etc., motor car No. 7 was given its first long-distance trial April 14th and 15th.

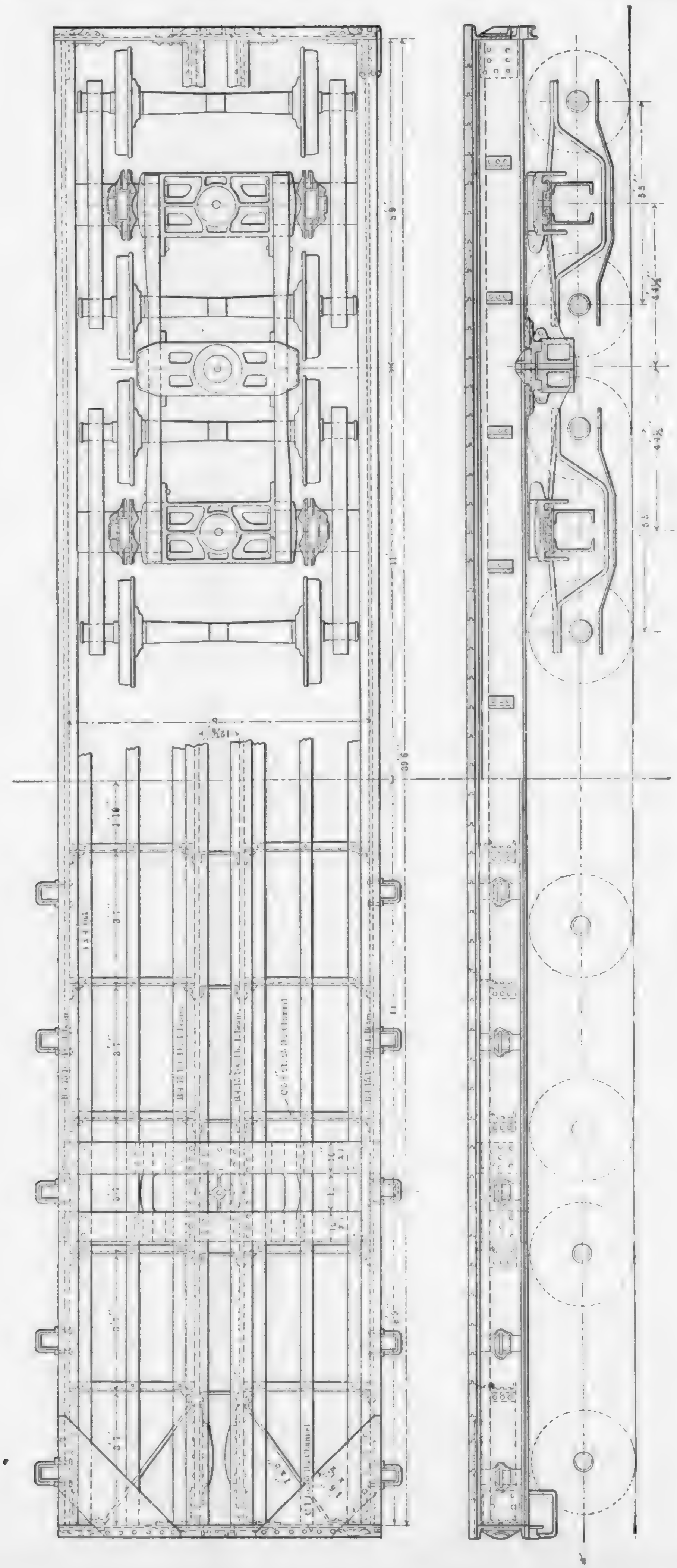
On April 14th it left Omaha as second section of train No. 1, Overland Limited. The motor car gained on No. 1 to such an extent that at Fremont, 46 miles from Omaha, it was held at the block. Owing to a heavy wind and meeting trains from this point on some time was lost on No. 1's schedule. However, the total time of motor car from Omaha to Grand Island was 5 hours 12 minutes, with a delay of 40 minutes account orders, meeting trains, etc., the actual running time for the 153.6 miles being 4 hours 32 minutes, or 34 miles per hour. There was no delay whatever on account of the motor car, and the machinery was in almost constant motion from Omaha to Grand Island.

On return trip April 15th a high-speed run was not attempted, and the car was delayed over 3 hours for orders, meets, etc., in addition to a slight delay on account of a hot bearing. The actual running time for the 153.6 miles was 4 hours 10 minutes, or 36.3 miles per hour. From Elkhorn to South Omaha, a distance of 24.3 miles, the time was 36 minutes, or 42 miles per hour. A maximum speed of 53 miles per hour was attained on this trip.

We are indebted to Mr. W. R. McKeen, Jr., superintendent M., P. & M., to whom credit is principally due for the success attained in the design and operation of all these cars, for the above information and illustrations.

RAILWAY STOREKEEPERS' ASSOCIATION.—The third annual meeting of the Railway Storekeepers' Association will be held at the Auditorium Hotel, Chicago, May 21, 22 and 23. An interesting program has been provided, and the indications are that the convention will be a very successful one.

CAPACITY OF THE LOCOMOTIVE.—Formerly the capacity of a locomotive was estimated largely from the capacity of its cylinders, and this led occasionally to the use of cylinders of such dimensions that the boilers provided were not capable of generating sufficient steam to enable them to be worked at their maximum economical power for any length of run. Today this is changed, and the first consideration is the capacity of the boiler.—*Mr. G. J. Churchward, before the Institution of Mechanical Engineers.*



100-TON CAPACITY FLAT CAR.—PLAN AND SIDE ELEVATIONS.

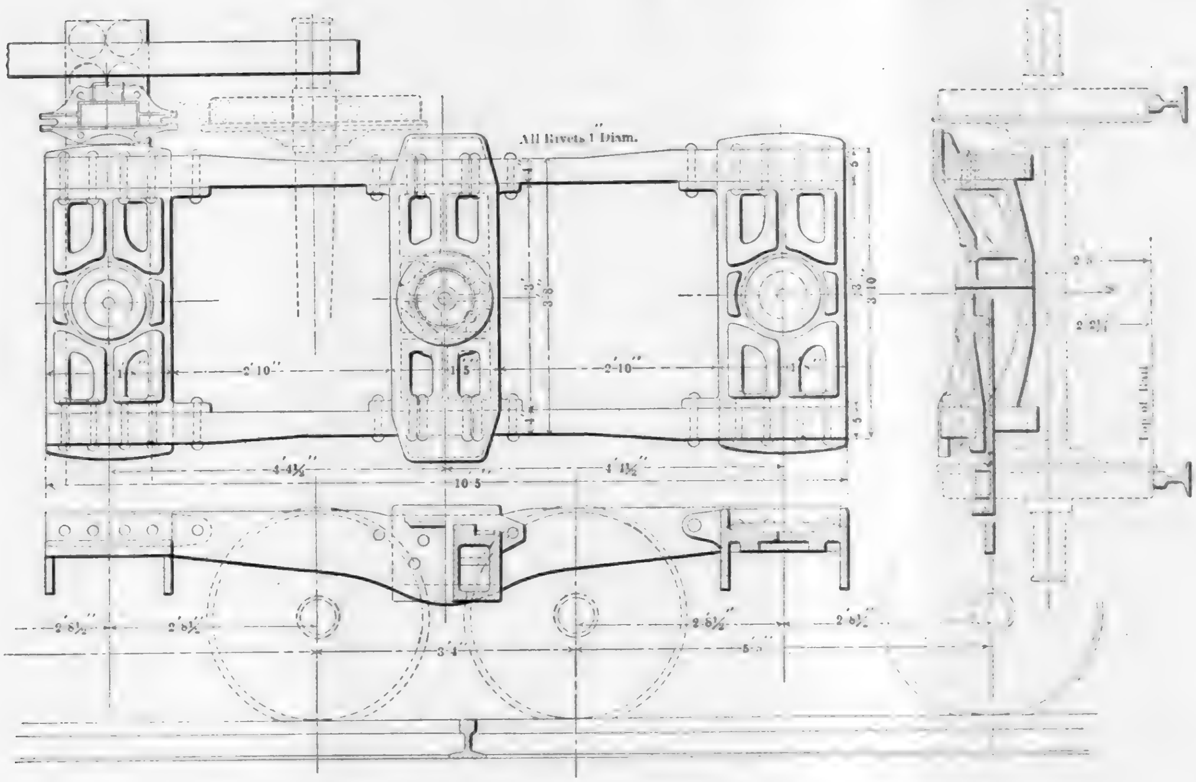
200,000 LB. CAPACITY FLAT CAR.

The desire to ship heavy castings and parts of large engines which often individually weigh more than 100,000 lbs. led the Allis-Chalmers Company, of Milwaukee, to request the mechanical department of the Chicago, Milwaukee & St. Paul Railway to design for them some flat cars capable of carrying 220,000 lbs. This work was turned over to Mr. James F. DeVoy, mechanical engineer, who, in connection with Mr. A. E. Manchester, superintendent of motive power, and Mr. J. J. Hennessey, master car builder, has designed the car shown in the illustrations herewith, two of which have been built at the West Milwaukee shops of the road.

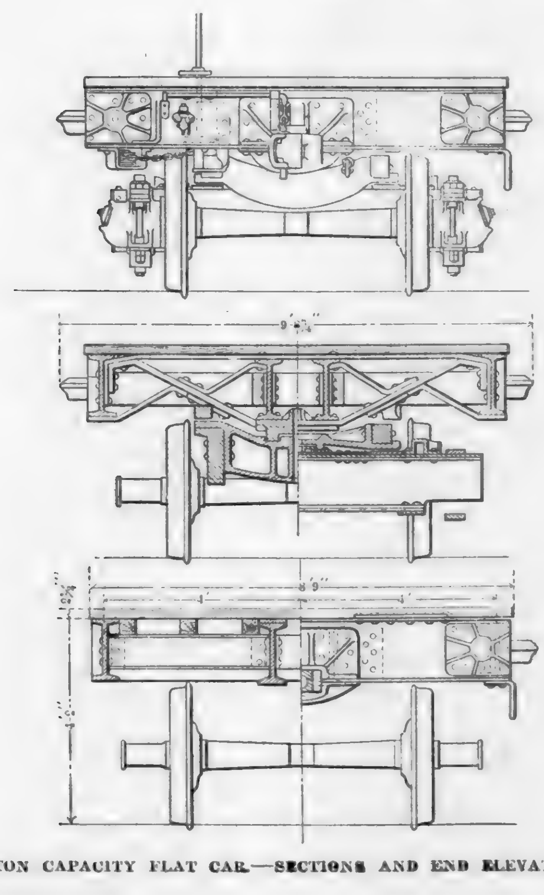
In the original discussion of the general features of the design it was decided that the car should have standard M. C. B. parts as far as possible, so that it could be easily repaired anywhere in the United States. This was particularly desirable in connection with wheels, axles, journal boxes and truck parts. Following up that idea, it was decided to use two 100,000-lb. standard trucks under each end of the car, these to be connected by a heavy cradle, in the centre of which would be the bearing for the car body and under which the trucks would have free movement.

This cradle connecting the two trucks consists of two short but very strong and carefully designed bolsters resting upon the truck bolster, which are connected by two heavy cast-steel side bars, in the centre of which is a cast-steel bolster on which the car body rests. This design is shown very clearly in the illustrations and its remarkable simplicity and strength are apparent. The bolsters resting over the trucks are broad and the truck centre bearing is located as high as possible, the strength being obtained by the deep flanges extending down on either side of the truck bolster. The side bars, which are 5 ins. square at the ends where they connect to end castings, are gradually made deeper and narrower until they measure 4 ins. thick and 14 ins. deep at the centre, the top at the centre being depressed 2 ins. for a distance to accommodate the centre castings. This centre casting is of steel and made deep and heavy, as it has to support a weight of 100,000 lbs. besides half of the car body. The lips passing over the side rails are extended beyond and form a bearing for the side bearings. The centre plate, which is cast integral with the bolster, is sunk down as low as possible, its bearing surface being 4 ins. below

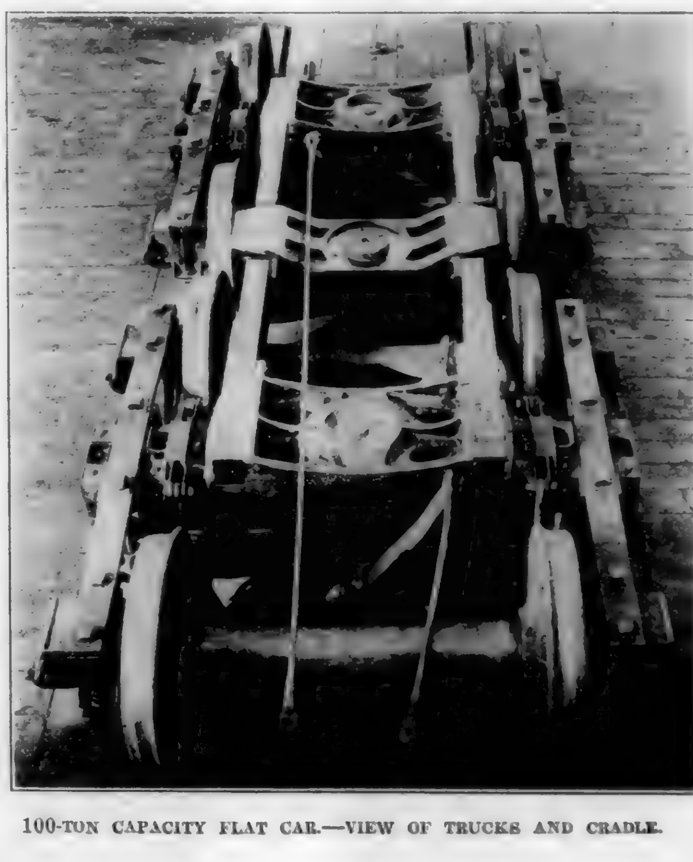
100-TON CAPACITY FLAT CAR.—ALLIS-CHALMERS CO.



100-TON CAPACITY FLAT CAR.—SECTIONS, ELEVATIONS AND PLAN OF CRADLE.



100-TON CAPACITY FLAT CAR.—SECTIONS AND END ELEVATION.



100-TON CAPACITY FLAT CAR.—VIEW OF TRUCKS AND CRADLE.

the level of the side rail. This cradle spaces the trucks at 8 ft. 9 in. centres, giving them room to curve freely. The bolsters over the trucks are given very slight side clearance, so that the rocking tendency at this point is very small.

The car body, which measures 40 ft. over end sills, is of simple but very strong design and consists essentially of four 15-in. 100-lb. I-beams running continuously from end sill to end sill, the two forming the centre sills being spaced $12\frac{7}{8}$ ins. between webs and the two side sills at 8-ft. centres. The centre sills are located 1 in. lower than the side sills. These are connected at the ends by 15-in. 55-lb. channnels with the flanges outward, which are fastened to the sills with very heavy corner irons securely riveted. For adding stiffness and strength at the corners there are $\frac{1}{2}$ by 18-in. gusset plates across the corners, and 1 by 8-in. diagonal braces from the end sill to the centre sill. At ten equally distant points there are 8-in. $21\frac{1}{4}$-lb. channel irons fitted between the centre and side sills and securely fastened to both by angle irons in the corners. At these points 1 by 8-in. flanged plates are fitted between the centre sills. These cross channels are located with their upper flanges 4 ins. below the top flange of the side sill and six 4 by 4-in. wooden nailing strips running from end sill to end sill are fastened to them and the floor of $2\frac{1}{2}$-in. wood is nailed to these strips.

Because of the height of this car, which is 4 ft. $4\frac{1}{2}$ ins. from top of floor to rail, it was necessary to cut out but a small section of the bottom of the end sill for the coupler shank to pass through, and at this point a heavy ribbed malleable casting acting as a stiffener has been fitted. On the outer end of each end sill are also heavy malleable iron push pocket plates.

The car bolster, which is located 8 ft. 9 ins. from the inside of the end sill, consists, as is clearly shown in the cross-section of the car, of a very heavy trussed steel plate design. Extending across the top of the two centre sills and flanged downward and riveted to the inside of the web of the side sills are two 1 by 10 in. plates spaced 12 ins. apart. Passing below the centre sills and extending upwards to the connection of these cover plates at the side sills, at which point it is flanged down and securely riveted to both, are two $1\frac{1}{2}$ by 10 in. plates. Diagonals are carried from the bottom of the side sills and from the top of the centre sills to these heavy trusses. The centre plate of heavy cast steel fits and is fastened to the bottom of the centre sills and the bolster trusses, as is clearly shown in the cross sections. The side bearings are simple castings fastened to the body bolster and bearing on the extension of the centre truck bolster mentioned above.

One of these cars has been tested for curving and it was found that it would take a 16-deg. curve without trouble. It is believed that they will take any curve over which other cars are operated.

We are indebted to Mr. James F. DeVoy, mechanical engineer of the Chicago, Milwaukee & St. Paul Railway for the drawings and photographs shown herewith.

PRODUCTION IMPROVEMENTS.

The accompanying illustrations show some special devices which are being used with good results at the Winona (Minn.) shops of the Chicago & Northwestern Railway Company.

Fig. 1 shows the application of a special mandrel and tool holders for turning eccentrics on a boring mill, and Fig. 2 shows the mandrel and also a chuck used for boring the eccentrics. The tool holder at the left, in Fig. 1, carries two high-speed tools ¾ in. square, and the holder at the right has four high-speed tools ¾ in. square set at the proper distance for webbing the eccentrics. A is a special brace for stiffening this tool holder, C is the mandrel, B-B are parting rings. In handling the eccentrics they are first planed and drilled and then placed in the chuck and bored, after which they are taken to a slotter and key-seated. They are then taken back to the boring mill, slipped on the mandrel, turned and webbed. With this arrangement three eccentrics are bored out per hour or two can be turned. The chuck can be designed to take care of eccentrics with a maximum throw, and can be fitted with set screws for adjusting it for other designs.

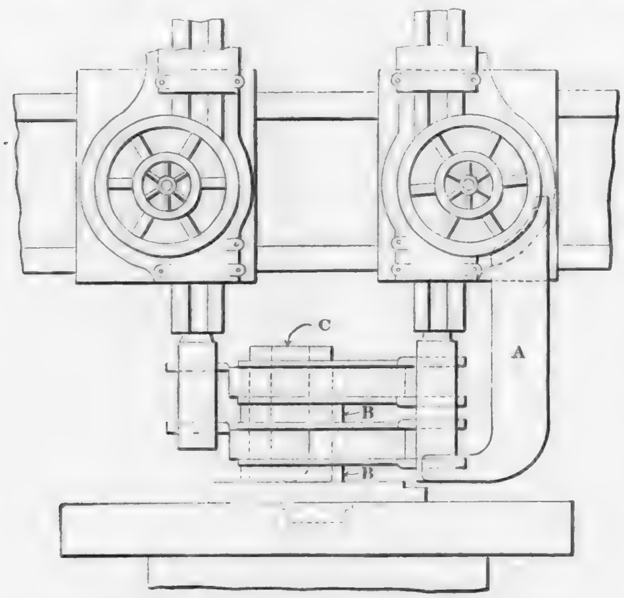


FIG. 1.—TURNING ECCENTRICS ON BORING MILL.

Fig. 3 shows a jig for drilling the driving wheel and eccentric keyways. The jig is slipped over the axle with the driving wheel keyway hole D central with a line scratched longitudinally on the axle when it is in the lathe. The arms b-b are set to a line on the jig. They are then tightened and held in place by nuts on the studs (c). This device saves

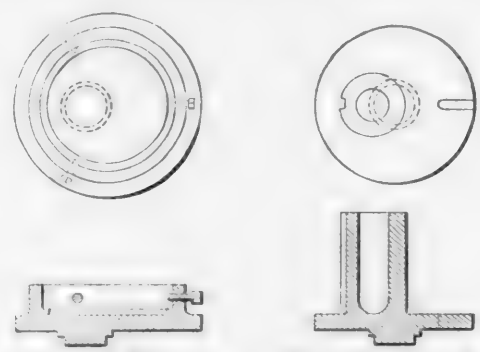


FIG. 2.—CHUCK AND MANDREL.

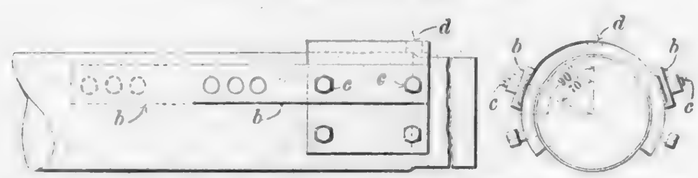


FIG. 3.—JIG FOR DRILLING DRIVING WHEEL AND ECCENTRIC KEYWAYS.

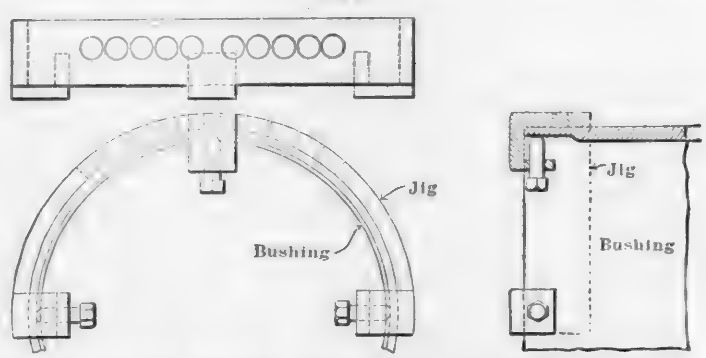


FIG. 4.—JIG FOR DRILLING STEAM PORTS IN CYLINDER BUSHINGS.

two hours of laying off by a high-priced machinist, and is so simple that it may easily be handled by a drill press boy.

The jig for drilling cylinder bushings for the steam ports (Fig. 4) is very simple. The lathe operator, while turning the bushing, scratches a line longitudinally on it and also a line at each end around the circumference at the center of the steam ports. All the drill press boy has to do is to set the jig central with these lines. We are indebted for drawings and information to Mr. V. T. Kropidlowski.

SUPERHEATED STEAM ON THE CANADIAN PACIFIC RAILWAY.

At the April meeting of the New York Railway Club Mr. H. H. Vaughan, assistant to the vice-president of the Canadian Pacific Railway, presented a paper on the use of superheated steam on that road. This paper, which deals largely with the results which have been obtained on the Canadian Pacific Railway, the pioneer in the introduction and use of superheated steam in this country, supplements the individual paper which was presented by Mr. Vaughan at the last meeting of the Master Mechanics' Association. The Vaughan and Horsey, or C. P. R. type of superheater, which has been developed since the first paper was written, was fully described on page 41 of our February, 1906, issue. The engines which were considered in the tests reported by Mr. Vaughan are as follows:

Class.	Type.	Number.	
700	4-6-0	10	Schmidt fire tube superheater.
710	4-6-0	55	Schenectady superheater modified.
740	4-6-0	30	Vaughan & Horsey, or C. P. R. superheater.
1200	2-8-0	41	Schenectady compound, no superheater.
1300	4-6-0	37	Schenectady compound, " "
1600	2-8-0	20	Schmidt fire tube superheater.
1621	2-8-0	21	Schenectady superheater ("Field" tube type).

The following are extracts from Mr. Vaughan's paper:

The "Schmidt," "Schenectady" and "C. P. R." superheaters now being applied on the Canadian Pacific are identical in every respect with the exception of the arrangement of the headers and the connection to them of the superheater pipes. The primary objects sought in the design of the "C. P. R." type were the separation of the joints from the heater pipes to the headers, the location of these joints in a position where they could be conveniently inspected and an arrangement of the superheater pipes that would permit any individual element being removed or applied without disturbing the others. These objects appeared desirable after the experience on earlier engines, and it is evident they have been very satisfactorily obtained. The first is also satisfactorily met in the "Schmidt" by the separate bolting of the superheater pipe flanges to the header, and its need did not develop to any great extent in the earlier engines with the "Schenectady," although later experience would suggest its necessity, as more or less trouble is developing with the joints between the superheater pipe and main headers. Both the second and third requirements are also partially met by the "Schmidt," but not as thoroughly as in the "C. P. R." design, and in both respects the "Schenectady" is deficient. It must not be understood that either of these types gives especial trouble in service or are difficult to maintain; in fact, the reverse is the case; but the points mentioned are conveniences and advantages which are believed to have been obtained by the modification illustrated, and their value will be appreciated from the roundhouse point of view.

The most important question in connection with superheaters is naturally that of the coal economy obtained, and this is not easily determined, as all who have followed the effect of different improvements or proportions of locomotives will appreciate. Tests are open to the objection that they do not represent general service conditions and coal records on account of their inaccuracy and lack of definite results. Tests on superheaters present, however, an additional difficulty over those directed to ascertain the relative economy of simple versus compound engines, or of wide versus narrow fireboxes, where the efficiency of either the boiler or engines alone is involved, in that they must necessarily include the efficiency of the machine as a whole. The determination of the water consumption per unit of work is not sufficient, as it is quite possible for any advantage shown in this respect to be neutralized by less efficient boiler performance. Even with equal boiler efficiency, the additional heat in the superheated steam would represent a reduction in the water evaporated of 1-20 of 1 per cent. for each degree of superheat, or 5 per cent. for 100 deg. and 10 per cent. for 200 deg. superheat. In other words, if an engine with 100 deg. superheat showed a saving in water consumption of 5 per cent., in comparison with an ordinary engine, and the boiler was equally efficient, there would be a saving in coal, and there must in addition also be some loss in boiler efficiency on account of the necessarily higher temperature of at least a portion of the smokebox with any design of superheater. This action has been discussed at length in the writer's previous paper and need not be further referred to, but, on account of it, it is necessary in comparing superheaters with other engines to measure the coal consumption per unit of work. To do this a rather extensive series of tests are required to average the influence of the efficiency of the firing with a dynamometer car to measure the work done, and owing to the latter not having been available during the past year it has been impossible to undertake them. During the past winter a car has been constructed which will enable some experiments to be made, but at present the only figures available are those showing the tons hauled and coal consumed on the various sections of the road, and as these, after all, are the final arbiters of economical working, they afford, so far as they are susceptible of proper comparison, the most satisfactory evidence that can be obtained. Such figures are not of great value when applied to individual engines, but when obtained from a number of engines, without specially selected crews, working together in regular service they must certainly be regarded as reliable.

The two general classes of superheaters, consolidation and ten-wheel freight engines, can only, on the Canadian Pacific, be compared with compound engines, as there are no simple freight engines in use on that road at all similar in size or design. Compounding has during the past few years become firmly established for freight service, and on account of the high cost of coal there would be no question as to its continuance had not the use of superheaters been introduced. Of compound engines there are, however, two classes which afford excellent comparisons; the 1200 class consolidation, of which there are forty-one in use, and the 1300 class ten-wheelers, of which there are thirty-seven. Both these classes are modern "Schenectady" compound engines, and although the 1200 class is rather lighter than the 1600, it has the same grate area and is a good engine for comparative purposes, while the 1300 class is practically identical with the 700 class, with the exception of the change from compound to simple superheaters.

The dimensions of the various classes are given in the following table. In comparing road coal records a good many difficulties are met with, some of which are usual on all roads, while others apply particularly to the Canadian Pacific Rail-

	1,200	1,300	1,600	1,621	700, 710 & 740
Boiler pressure	200	200	200	200	200
Firebox width, inside	65 3/8	70 1/4	65 1/4	65 1/4	69 5/8
" length, "	96"	102 1/8"	96 5/8"	102 1/8"	....
Number of ordinary tubes	281	378	244	255	244
Diameter of ordinary tubes	2"	2"	2"	2"	2"
Number of special tubes	....	....	22	55	22
Diameter " "	....	....	5	3	5
Length of tubes	14'2"	14'-6 11/16"	14'-1 3/8"	14'-2 3/8"	14'-2 3/8"
Number of superheater pipes	....	....	88	55	88
Diameter superheater pipes	....	....	1 1/4	1 3/4	1 1/4
Heating surface tubes	2,084	2,885	2,216	2,705	2,233
" " firebox	134	180	[illegible]	165	180
" " total	2,218	3,065	2,381	2,870	2,413
Superheating surface	....	....	375	340	[illegible]
Grate area	43.6	50.0	43.6	43.6	[illegible]
Cylinders	22x35	22x35	21x28	21x28	21x28
Driving wheels	57	63	57	57	[illegible]
Total weight of engine	159,500	190,000	186,200	186,200	190,000
Weight of drivers	140,500	142,000	163,700	163,700	141,000
Weight of tender	114,000	122,000	121,500	121,500	122,700
Water, imperial gals.	5,000	5,000	5,000	5,000	5,000
Coal, tons	10	10	10	10	10

way.

way. The easiest figures to arrive at, those based on general averages, are not by any means reliable, and considerable of the peculiar traffic conditions moved from one section to another more than is usual on most roads. Most engines have assigned crews, and in consequence those engines doing the greatest amount of work on any section as a rule give better relative results than those making fewer trips, as the latter are extra crewed and the men are not so interested with the results. Taking these points into consideration, it will be seen that records made during the summer where weather conditions are most equable afford, on the whole, the most reliable results; provided the different engines do sufficient work on a section to reach a fair average, and this can be most easily watched by noting the total amount of coal consumed. The following table shows the results obtained from the 1200, 1300, 1600 and 1621 class engines on the various sections of the Lake Superior division for the months of May to October, 1905, the column relative to consumption showing the consumption reduced to the 1200 class as 100:

SECTION.	Class of Engine.	Number of Class Hauled.	Total Coal Consumed.	Coal Consumed Per Unit Mile.	Relative Consumption.
Chalk River—North Bay....	1621	7	3,048¾	128	97
	1600	5	964½	112	85
	1300	3	175	114	86
	1200	8	1,121¾	132	100
North Bay, Cartier, Webbewood....................	1621	7	1,473¾	127	104
	1600	7	588¾	106	87
	1300	4	510¾	113	92
	1200	12	1,758	122	100
Schrieber—Fort William..	1621	5	134½	145	122
	1600	3	34¾	96	81
	1300	4	743¾	141	118
	1200	16	3,876	119	100
White River, Schrieber.....	1621	6	274¾	159	119
	1600	3	89	134	101
	1300	4	775¼	150	113
	1200	17	4 788¼	133	100
Chapleau—White River ...	1621	3	265	140	96
	1600	11	4,126¾	121	83
	1300	3	845¼	142	97
	1200	15	515	146	100
Cartier—Chapleau.........	1621	4	245¼	126	82
	1600	10	3,684¾	117	76
	1300	4	565½	148	96
	1200	10	728¼	154	100

These records must certainly be regarded as satisfactory evidence in favor of the superheaters of the 1600 class, but it must be noted that between Schrieber and Fort William and Schrieber and White River these engines did not do sufficient work for the results to be of any value. On the remaining four sections the results show their relative economy to be 85, 87, 83 and 76 compared with the 1200 class, which is fairly conclusive. The 1621 are evidently not quite as economical as the compound, which is accounted for by there only obtaining about 20 deg. of superheat as against 80 deg. to 100 deg. in the 1600 class, as shown in the diagrams reported to the Master Mechanics' Association.

The above statement covering the summer months is the only one that can be properly averaged, and it does not include any of the 700, 710 or 740 class engines. These were delivered in September, 1905, and immediately went into service on the Central division between Fort William and Winnipeg, where they can be compared with a number of the 1300 class working in the same district. There are three sections on this piece of line, and as the relative economy of the engines varies with the sections they must be given separately.

These sections vary considerably in their grades and traffic conditions from the Lake Superior division. On the latter the grades are nominally 1 per cent., with an undulating profile, and on such a line a consolidation engine is more economical than a ten-wheeler. Between Winnipeg and Fort William the line is fairly level, and as the load is heavy, the work uniform, and the speed fairly high, the 1300 class has been found to be the most economical engine that could be obtained. The following table indicates the difficulty in comparing coal records, but the conclusions would be that the 700 and 710 classes are equal to the 1300 class between Winnipeg and Kenora, slightly inferior to it between Kenora and Ignace, and slightly superior between Ignace and Fort William, while on the latter section the 740 class are decidedly more

Month	1300 Class.		700 Class.		710 Class.		740 Class.	
	Coal Consumed.	Coal per unit mile.	Coal Consumed.	Coal per unit mile.	Coal Consumed.	Coal per unit mile.	Coal Consumed.	Coal per unit mile.
FORT WILLIAM TO IGNACE.								
Sept.	1471	98	48	123	121	114	1082	79
Oct.	3712	102	75	100	352	104	2252	85
Nov.	3922	103	9½	82	175	98	1881	93
Dec.	2510	113	74	101	1162	104	626	96
Jany.	1528	109	.	...	1182	100	....	..
Feby.	...	...	..	...	....	...	...	..
IGNACE TO KENORA.								
Sept.	480	100	907	90	1614	98	..	..
Oct,	1289	99	1927	104	3672	109	..	..
Nov.	573	111	1774	106	3925	114	.	..
Dec.	146	116	919	101	3367	113	10	97
Jany.	32½	154	546	115	2405	113	..	..
Feby.	.	...	....	...	....	...	..	..
KENORA AND WINNIPEG.								
Sept.	785	93	405	93	1550	91	...	...
Oct.	2416	103	463	100	3090	101	...	...
Nov.	2324	104	308	120	2872	110	29½	101
Dec.	1727	115	471	119	1873	115	11	102
Jany.	1167	114	524	106	1058	117	...	...
Feby.	. .	.	...	...	....	...	...	...

economical than either of the others. It is evident, however, that to average these figures would not give an accurate result on account of the variable amount of work done each month. The most satisfactory plan, if records were absolutely accurate, would be to continually compare with one class, and the average increase or decrease could then be obtained. It can easily be seen that if the class compared with used a small amount of coal during any one month the comparisons made with it might be widely misleading; for instance, were the 1300 class taken as a standard, the results of the other engines would show an enormous economy in January between Ignace and Kenora. If, however, in each month the engine using the largest amount of coal is taken as a standard, and the amounts which the other classes would have consumed at its rate are calculated, a comparison of the coal actually used as against that which would have been used is obtained which affords a reasonable measure of their economy. A hypothetical illustration of this method is as follows:

Month.	1200 class.		1600 class.		1621 class.	
	Coal consumed.	Coal per unit mile.	Coal consumed.	Coal per unit mile.	Coal consumed.	Coal per unit mile.
May..........	680	120	796	115	.....	.....
June..........	80	105	600	118	500	135
July..........	110	130	100	140	900	130

Results by comparing with class burning most coal

Month.	1200 class.		1600 class.		1621 class	
	Used.	Equivalent	Used.	Equivalent	Used.	Equivalent
May..........	680	650	796	796	...	....
June..........	80	90	600	600	500	436
July..........	110	110	100	93	900	900
Total	870	830	1496	1489	1400	1336
Relative Consumption	102.5		100.5		105.0	
Or	100		98		102.5	

This method tends to minimize the variations which occur, and is thus conservative in its results; it is also inapplicable where the classes of engines to be compared do not work together on the same sections to a sufficient extent to obtain fair comparison, and is thus in some ways not as satisfactory as deductions drawn from a study of the records; but it has the advantage of eliminating all personal element, and is the

only system so far devised by which any reasonable compilation of records extending through several months on various sections can be made.

The records given above for the Central division, September to January, inclusive, when compared in this manner yield the following results:

Section.	1300		700		710		740	
	Coal Used	Relative Consumption	Coal Used	Relative Consumption	Coal Used	Relative Consumption	Coal Used	Relative Consumption
Fort William to Ignace	13,144	100	207	101.0	2 993	88.5	5,842	84.7
Ignace to Kenora	2,520	100	6,073	98.3	14,982	105.0	.	....
Kenora to Winnipeg	8,416	100	2,170	100.8	10,443	100.5	....	...
Total	24,080	100	8,450	100.7	28,418	99.5	5 842	85.5

The records on the Lake Superior Division for the months of May to January inclusive when compiled in the same way give the following results:

SECTION.	1200		1600		1621		1300		710		740	
	Coal	Consumptn	Coal	Consumptn	Coal	Consumptn	Coal	Consumptn	Coal	Consumptn	Coal	Consumptn
Chalk River—North Bay	5122	100	1301	905	3709	102.	[illegible]	100.6	......	......	160	90.7
North Bay—Cartier	3571	100	860	94.8	2248	104.6	823	91.2	......	......	245	[illegible]
Cartier—Chapleau	1609	100	6990	84.6	432	98.2	1275	95.0	5:3	89.	666	96.7
Chapleau—White River	1448	100	7563	93.2	459	105.5	1018	103.0	642	102	491	90.4
White River—Schreiber	7990	100	586	112.2	1465	106.7	936	111.6	[illegible]	100	467	[illegible]
Schreiber—Fort William	7063	100	430	100	1564	109.7	[illegible]	113.5	403	102	[illegible]	90 0
Total	25012	100	17790	98.5	9877	104	5836	108.5	1944	104.2	2.78	94

It is interesting to note that the above results may also be compared as follows using the compounds of each type as a basis.

DIVISION.	TYPE.	COMPD.	SCHMIDT	SCHEN. A	SCHEN. B	C. P. R.
Lake Superior	Consolidation	100	98.5	104	....	....
	Ten Wheel	100	....	....	98.0	88.0
Central	Ten Wheel	100	100.7	. .	99.5	85.5

Assuming these comparisons to be accurate, and after careful study the writer certainly believes them to be conserva-

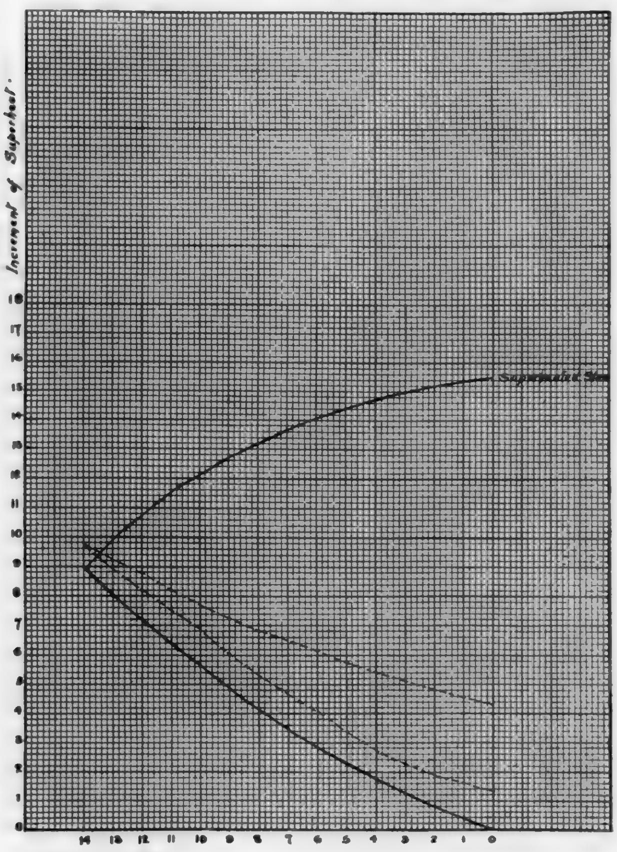


FIG. 10.

tive, the superheater locomotive has evidently shown itself to be rather more economical than the compound with the amount of superheat obtained, on the "Schmidt" and "Schenectady B" design, and from the good results obtained from the C. P. R. engines there is every reason to believe that still further economies will be reached. The results from these engines were entirely unexpected, as the design was developed from a mechanical standpoint entirely, and they are not by any means easy to explain, except that they must be caused by the steam being heated to a higher temperature than in the

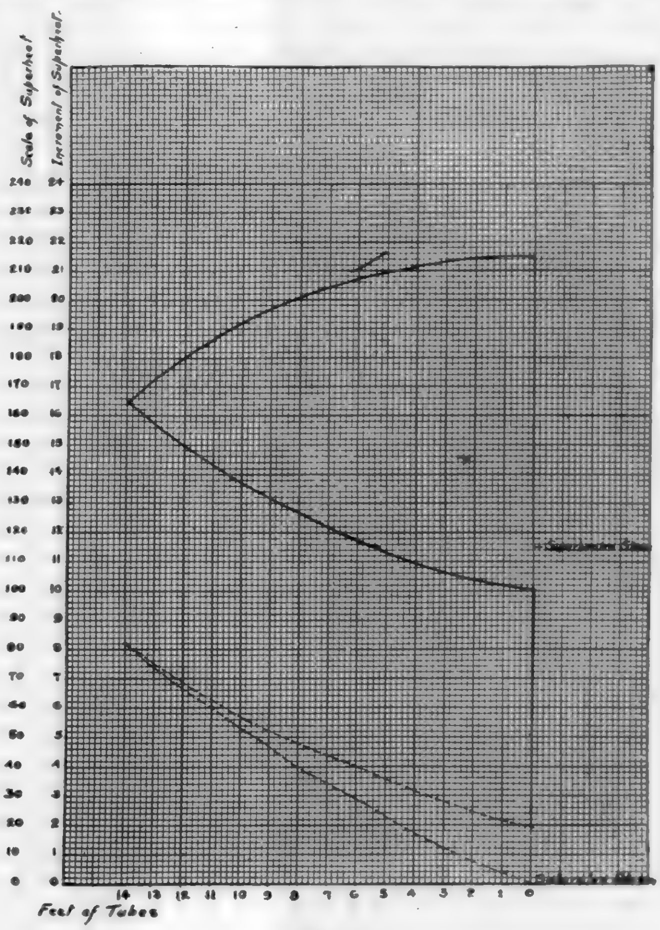


FIG. 11.

"Schmidt" or "Schenectady" engines. Since this was not discovered until December, it has been impossible to carry out proper temperature tests, on both types, but one made on one of the 740 class engines would indicate a higher superheat of about 40 deg. In view of the superheating surface being identical, this can only be explained by the peculiar arrangement of the headers which prevents any abstraction of heat from the steam after it has been superheated by the entering steam by the tendency to a more equal flow of the steam through the various superheater pipes in passing from one header to another. In support of the first reason the poor results obtained from the "Schenectady A" type are of interest. With 340 square feet of superheating surface against 375 in the "Schmidt" engine, the superheat was only about 20 deg., as against 100 deg. This would show that any reduction in the temperature of the superheated steam by transferring its heat to the entering saturated steam is not as might be expected compensated for, and that the degree of superheat finally obtained may be seriously diminished by such action. The reason for this is not very clear, but a key to it may be found in the following diagrams, which have been worked out on the following data:

(a) Firebox temperature 2,000 deg., smokebox temperature 800 deg., flue 16 ft. long (at point 1. from firebox) $= 2,000 - 200\sqrt{1.}$

(b) Radiation from superheater tubes equal to that from blackened copper in vacuo = .0854 BTU per min. per square foot per degree F.

(c) Boiler with 88 superheater pipes $1\frac{1}{4}$ in. O. D. 12 ft. long using 20,000 lbs. steam per hour with 150 deg. superheat without abstraction of heat after superheating.

(d) Specific heat of superheated steam 0.6.

The full lines show the temperature of the superheated steam on its passage from the header through the tubes and back, and the dotted lines the increment of temperature per ft. Fig. 10 shows the form of these curves when the steam enters the tubes at boiler temperature, and Fig. 11 where its temperature has been raised 100 deg. by contact with the superheated steam, which in its turn is lowered 100 deg. by this action. It will be seen that there is a loss of 50 deg. by the transfer of heat on account of the increased radiation from the superheater pipes to the boiler, and the decreased transmission of heat from the flue gases to the superheater tubes. These diagrams are not presented with the idea that they are quantitatively accurate, but to illustrate the actions which account for the loss when heat is transferred from the superheated to the saturated steam.

The results obtained from engine 820 in passenger service have been very encouraging as have also those from the Pacific type. A graphic record of a test made on No. 820 (American Engineer, February, 1906, page 42), shows that the superheat obtained varies from 160 deg. to 200 deg. at the steam chest. This engine has been in service since last June on the Lake Superior division between Chalk River and North Bay, and the results for five months, June to October inclusive, compared to those obtained from two other identical engines on the same section, were as follows:

Eng. No.	Tons consumed.	Lbs. coal per gross ton mile.	Relative consumption.
820	734	143.5	100
823	763	160.0	111.5
838	913	199	138.5

There is a difference in the runs in which these engines are employed, all making three stops, but engine 820 having 11 flag stops against two for the other engines, which would, of course, increase the relative consumption of 820, so that while unsatisfactory on account of these figures referring to one engine there is still but little doubt that the superheater is very satisfactory and economical in passenger service, and its relative economy does not decrease with increase of speed as is the case with compounds. The repair question is so far unimportant and nothing has developed to show that superheater engines will exceed appreciably simple engines when expenses that are fairly due to experimental construction are excluded. Lubrication on a superheater is identical with that on a simple, with the exception of the additional cylinder connection required, and what is wanted is simply to deliver the oil to the required spot.

In conclusion the writer sees no reason to change the opinion previously arrived at that the superheater steam locomotive attains equal or greater economy than the compound without any of its disadvantages, and would now add to this by stating that the employment of higher temperatures with the still further economy is relatively practical and to that on engines now under construction the proportions of superheating surface will be increased to attain this result. It is especially advantageous in passenger service and so far no counterbalancing disadvantages have been developed which are worth considering. Whether this is due to special conditions on the Canadian Pacific Railway, or not, superheating is certainly successful on this road, and there is so far no inclination to discontinue it.

The International Railway Master Boiler Makers' Association.—The fifth annual convention of this association will be held at the St. Charles Hotel, Milwaukee, Wis., beginning May 15th. Committees will report on the following topics: Progressive tools for boiler works; handling of engines on ash pits and in roundhouses, also proper regulation of dampers; best method of inspecting and testing locomotive boilers; modern design and construction of locomotive boilers; Belpaire vs. radial-stay boilers; arch tubes and arch bricks, what benefit and how applied; best method of applying and maintaining staybolts in all their forms; how to remedy cracked and leaky mud rings.

THE PENNSYLVANIA RAILROAD'S EXTENSION TO NEW YORK AND LONG ISLAND.

(Continued from page 179.)

sion main circuits, together with the cross section of the electrical gallery given herewith, show the general arrangement of the wiring and the location of the instruments. In the diagrammatical view of the high tension circuit the three conductors of the three-phase circuit are shown as one line. The generators are designed to run in parallel on either of two sets of main bus bars, called the working and the auxiliary bus, but one set of which is generally in use. The cables from the generator run through conduits in the foundation to the basement of the electrical section, and thence to the main generator circuit breakers, which are of 600 ampere capacity each. From thence they pass the generator selector circuit breakers, of which there are two, one on each of the circuits to the two sets of bus bars. They are also of 600 ampere capacity. Between these circuit breakers and the bus bars are the main generator switches, consisting of four-pole high tension oil switches, the fourth pole being for the grounded neutral connection.

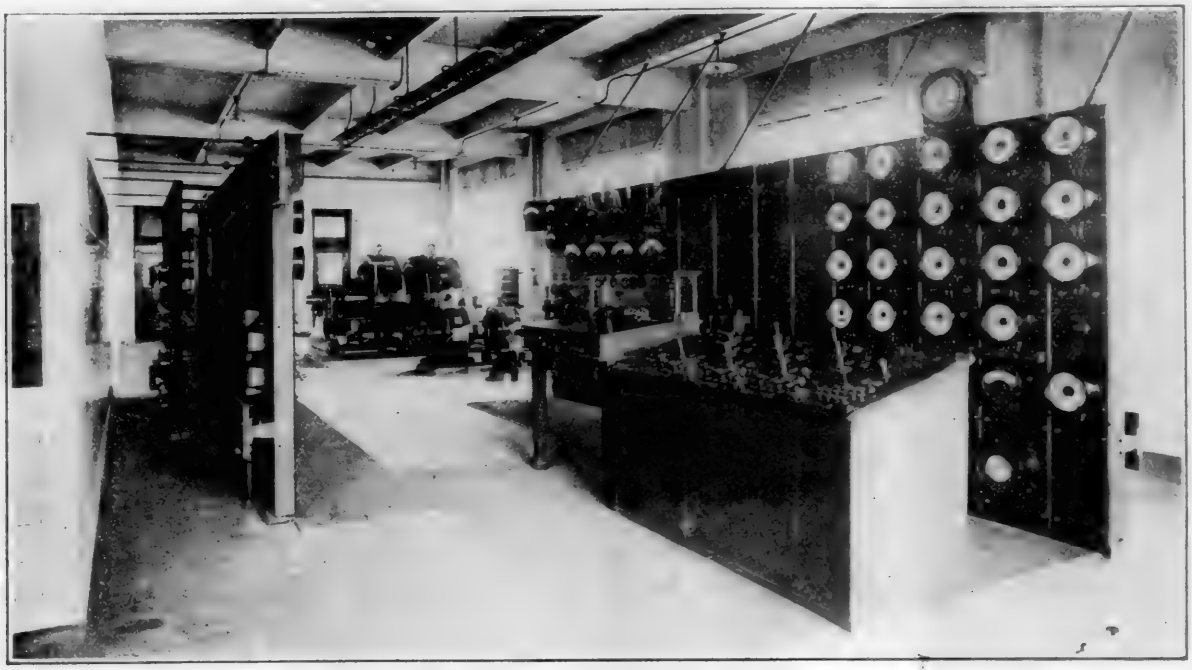
The feeder circuits are taken through feeder circuit breakers from group bus bars, each of which is arranged to accommodate six feeder circuits. These groups of buses have connections to the two main sets of bus bars through group selector circuit breakers of 1,200 ampere capacity and three-pole oil switches. By this arrangement any group of feeders can be connected to either the working or the auxiliary bus bars, which in turn can also be connected to any generator or number of generators.

All of these switches, circuit breakers, bus bars, etc., are located in the three lower floors of the electrical section, enclosed in thoroughly insulated receptacles, and while arranged for convenient inspection the possibility of any short circuits or grounding of the apparatus is practically eliminated. All of the movable apparatus is operated by means of electro-magnets controlled from the operating gallery.

The low tension exciting circuits also have two sets of 250 volt bus bars, to which are connected the different exciting systems through the proper circuit breakers and main switches. This arrangement is clearly shown in the diagram. It will be seen that the current for the induction motor is transformed from one of the regular feeder circuits.

One of the views herewith shows the interior of the operating gallery, which is provided with an overhanging observation balcony, giving a good view of the whole engine room. In this room are located all of the instruments showing the condition of all the circuits as well as the control for operating the switches, circuit breakers, etc. The complete apparatus consists of the following: A generator control bench, which is in the form of a low desk with an inclined top, containing the operating handles for the generator main and selector switches, control for the generator main and selector circuit breakers, control for the turbine governor, control for the field switch and control for the field rheostat. On this bench are also the control for the switches connecting the different sections of the main bus bar. Directly in front of each generator panel on the bench is a vertical panel containing the generator instruments consisting of a voltmeter, ammeter, indicating wattmeter, power factor meter, etc. There is also a synchronizing lamp and a lamp indicating the position of the field rheostat, besides an illuminating indicator, forming the return signal from the engine room, on this board. These instruments are all operated by current derived from shunt potential transformers and series transformers suitably located in the leads from each machine.

The feeder switchboard, facing the generator board, consists of three vertical panels, each containing apparatus for the control of six feeders and two feeder group selector switches. Each panel contains ammeters, controllers for circuit breakers with indicating lamps and switch and circuit breaker control.



VIEW OF OPERATING AND INSTRUMENT BOARDS IN OPERATING GALLERY.—P. N. Y. & L. I. POWER HOUSE.

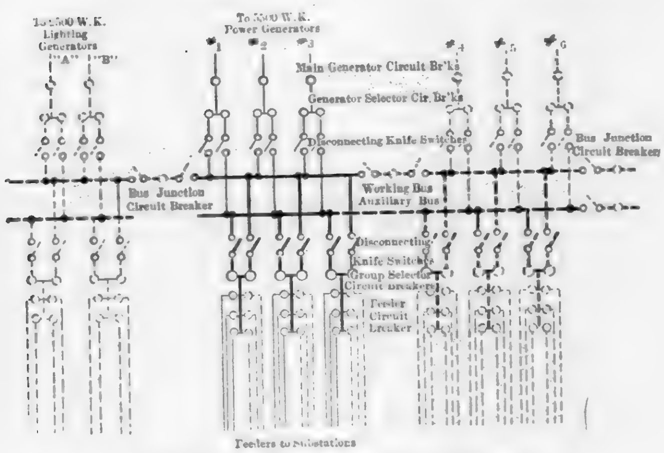


DIAGRAM OF HIGH TENSION CIRCUITS.

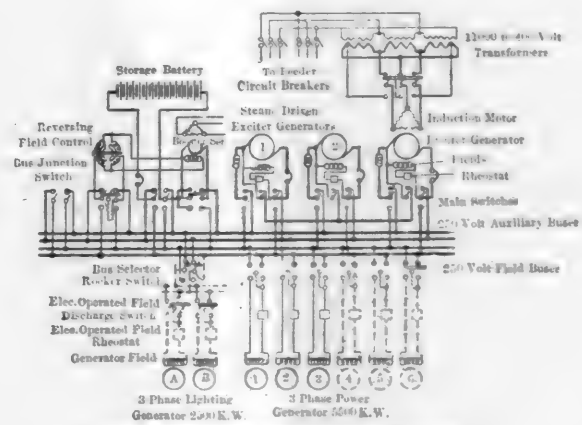


DIAGRAM OF LOW TENSION CIRCUITS.

The exciter switchboard is to the left of the generator instrument board and contains similar instruments and switches. A separate auxiliary switchboard controls the supply to the various direct current motors and lighting systems throughout the station and from it is also supplied the current required for operating the generator selector and feeder oil switches. From this point is also controlled the circuits for the electric telpherage system for the disposal of ashes, motor for operating the float bridge in the ferry house, boiler room elevator, hot well pump motors, engine room crane, air compressor and a number of other electrically operated devices throughout the station and vicinity.

ENGINE ROOM SIGNALS.—The system of signals for intercommunication between the engine men and the electrical operator, consists of a number of illuminated signs grouped together and located at a point visible from all parts of the engine room. The large letters and figures forming the signals are illuminated from behind by incandescent lights, which are lighted when the proper contact keys in the gallery are pressed. An answering system from the engine room to the gallery is also included.

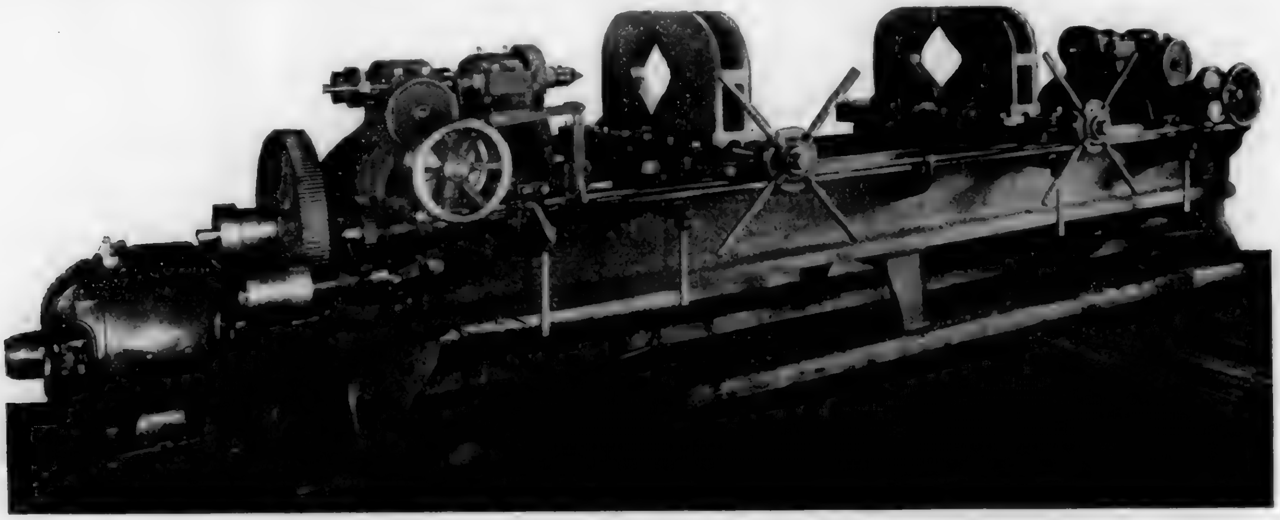
A large synchronscope is mounted above the signals and from it the engine man is informed when the generator approaches synchronism, and is switched into service. There is also a load indicator located in the engine room and boiler rooms, which shows the operating force the condition and tendency of the station load,

MACHINE SHOP.—A complete machine tool equipment for making light repairs has been installed on the floor just above the electrical gallery. It consists of a forge, pipe threading machines, bolt cutter machine, lathe, planer, drill press, etc. These are arranged in two groups connected to shafts driven by induction motors. A swinging jib crane with a 25 ft. hoist is provided for lifting pieces from the engine room floor to the machine shop.

The first work of clearing the site for this station began on September 15, 1903, and the excavation on October 20th. The first turbine was started January 16, 1905, and the high tension was first turned into the transmission lines on April 27, 1905.

The station was planned and built by Westinghouse, Church, Kerr and Company, engineers for the Pennsylvania, New York and Long Island Railroad Company, which is the organization through which the Pennsylvania Railroad is carrying on its New York extension work. The design and construction were under the charge of Mr. George Gibbs, chief engineer of electric traction of the road and under the general supervision of the mechanical and electrical advisory committee—New York extension—a committee composed of officials of the Pennsylvania Railroad.

It was suggested at the Traffic Club of Pittsburg, that traveling gangs of car repair men could advantageously repair half the discarded cars where they stand.



DOUBLE HEAD CENTERING MACHINE.—THE NAZEL ENGINEERING & MACHINE WORKS.

DOUBLE HEAD CENTERING MACHINE.

The double head centering machine illustrated herewith, one of which is in use at the Altoona shops of the Pennsylvania Railroad, is primarily designed for centering locomotive driving axles. It has a capacity up to 8 ft. 6 ins. in length, and the chucks will take axles from 4 to 14 ins. in diameter. The two chucks or vises are self-centering, and are adjustable along the bed. The centering heads are also adjustable along the bed. The spindles of the centering heads have a travel of 5½ ins., and may be operated either automatically or by hand, the large hand wheel in front of the heads being used for the hand feed, while worm wheels are operated by worms on the feed shaft for the power feed.

Above the feed shaft, which is the lower shaft running lengthwise of the bed, is a feed release rod which provides for the automatic release of both centering spindles when they have reached a predetermined depth. The capstan wheels in front of the bed are for closing the chuck jaws. The handles hanging down in front of the heads and chucks are ratchet levers for moving them along the bed. The machine is provided with three feeds, and is driven by a 5-h.p. General Electric 220-volt motor mounted on a bracket bolted to the machine, as shown. The rawhide pinion on the motor shaft meshes with the large spur gear on the machine. The machine, including the motor, occupies a floor space of 4 by 18 ft., and weighs about 10,000 lbs. It is made by The Nazel Engineering & Machine Works, Philadelphia.

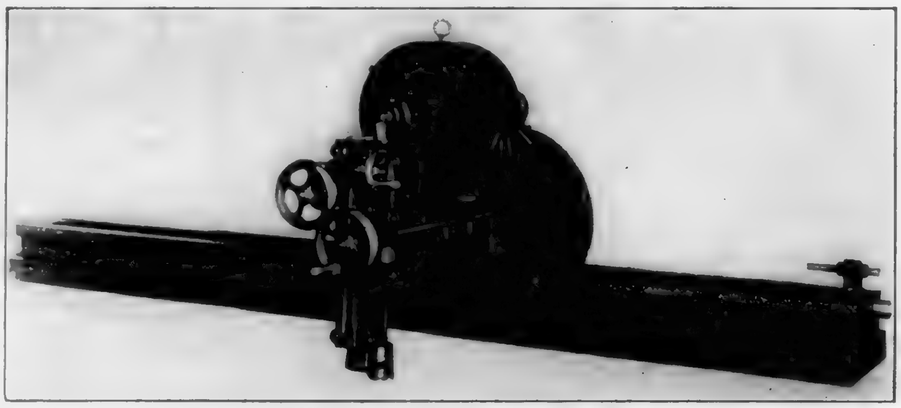
BOOKS.

Valve Gears for Steam Engines. By Cecil H. Peabody. Second edition. Thoroughly revised. 142 pages, 33 folding plates. Published by John Wiley & Sons, New York, 1906. Price, $2.50.

This is a revised edition of the former book by the same author, and is stated to be intended to give engineering students instruction in the theory and practice of designing valve gears for steam engines. The authors aim has been to give the learner a firm grasp of the principles of valve gears and some facility in their application. Each type is illustrated by one or more examples selected from good practice. The book includes careful descriptive matter thoroughly illustrated by drawings of each type of valve gear now in use. All analytical demonstrations relating to principals are given in the appendix. The Zeuner valve diagram is used. Careful attention has been given throughout to make the book simple and easily understood. Problems and their solution are included in each chapter. This book will be found to be of value for reference as well as for instruction.

PORTABLE MILLING MACHINE.

The portable milling machine, illustrated herewith, is designed for work up to 8 ft. in length. As it is motor-driven, it may be taken to the work, and thus can easily do work which could not be handled by other classes of tools. The carriage has a travel of 8 ft. with automatic feed; the cross slide has a movement of 12 ins.; the vertical spindle has a taper hole to receive taper shank mills, and has a movement of 10 ins.; the cross slide has a hand feed. The bed is mounted on a sub-base; and may be accurately adjusted by set screws and taper space pieces, which securely hold the two beds together. The sub-base is fitted with long slots and projections for attaching it to the work by clamps or bolts. This machine has been developed at the works of the Underwood Company, of Philadelphia, and has been added to the line of tools which they manufacture.



UNDERWOOD PORTABLE MILLING MACHINE.

RAILWAY GENERAL FOREMEN'S CONVENTION.

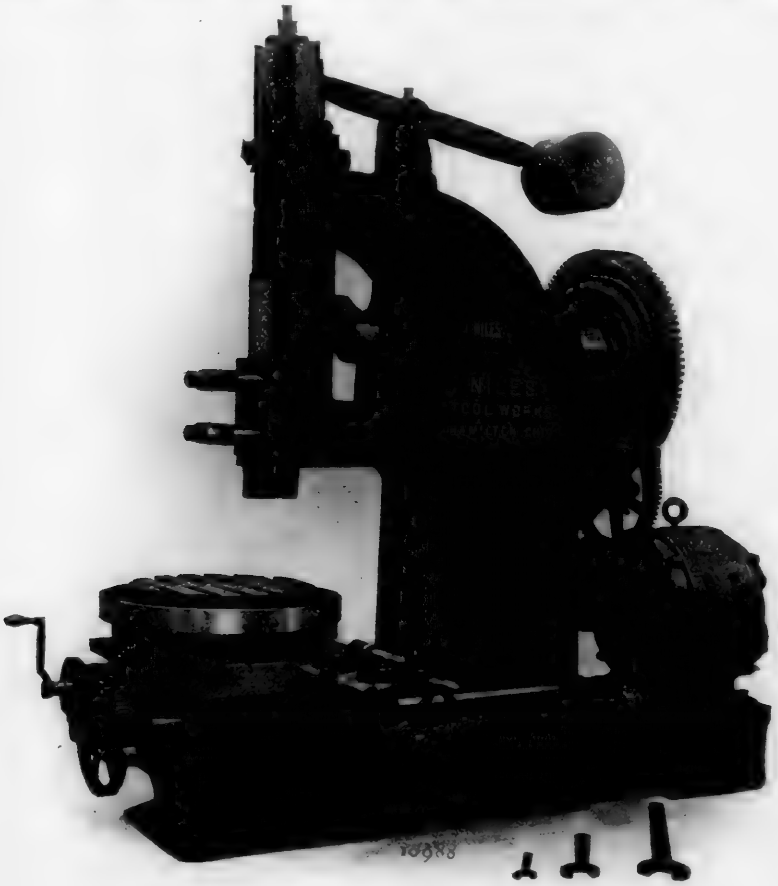
The annual convention of the International Railway General Foremen's Association will be held at St. Louis, Mo., beginning Tuesday, May 8th, at 10 a. m. All sessions will be open to those interested in the mechanical department of railway service. Those eligible to active membership are: General foremen, superintendents of shops, division foremen, machine foremen, roundhouse foremen and assistants of railway locomotive repair shops. Applicants can be recommended by an active member or master mechanic, or superintendent of motive power. The Jefferson Hotel has been chosen as the official headquarters.

The following is the list of topics to be discussed: 1. How can we best organize to take every possible advantage of convention opportunities for the interchange of ideas and the

promulgation of the most advanced methods of shop procedures and discipline? Legitimate reasons why an organization of foremen should exist—Our aims and educational possibilities presented.—Paper by D. E. Barton. 2. Modern Machine Shop Practice. Its economic phase to include a statistical comparison with the year 1895.—Paper by Lee R. Laizure. 3. The Duties of the Foremen. Their relation to each other. The advisability of weekly or semi-monthly meetings of the shop foremen. The necessity for mechanical literature to the end that we keep in touch with the world of mechanics.—Paper by G. W. Keller. 4. Broken Frames. Which is the best method of welding a broken frame, by the use of Thermit or to take down and weld in the blacksmith shop?—Paper by C. H. Voges. 5. Pooling Engines. Do we get as good results by pooling engines as we do by having regular crews on them?—J. C. Wilkinson, chairman. 6. Electric Lights. What advantage has an electric light over the oil light, taking into consideration the expense of keeping it up and the effect it has on the eyes of the engineer?—A. S. Abbott, chairman. 7. Motive Power by Electricity. What relation will electricity have to the motive power on the railroads in the next ten years? Will it ever supersede steam, and will it ever be a success?—L. H. Raymond, chairman. 8. Cause of Leaky Flues. What causes leaky flues? Is it the handling of the engine, or the water used, or is it the workmanship?—B. E. Greenwood, chairman. 9. Qualities of a First-Class Roundhouse and Division Foreman.—Paper by G. H. Gates. 10. Pooling of Engines. Its mechanical and financial aspect.—Paper by W. H. Graves.

12-INCH SLOTTING MACHINE.

This is an extra heavy machine designed especially for forge work. The ram is provided with removable tool clamps on the front face and with a relief tool holder on the end. The crank is forged in one piece with the driving shaft. The ram and crank are both corrugated under the connecting rod washers to avoid slipping. The driving shaft has the Whitworth quick return motion with a large cone and driving gear. The work table is 26 ins. in diameter, has 18-in. longitudinal and 18-in. cross motion, and has a water channel all around.



NILES 12-INCH EXTRA HEAVY SLOTTING MACHINE.

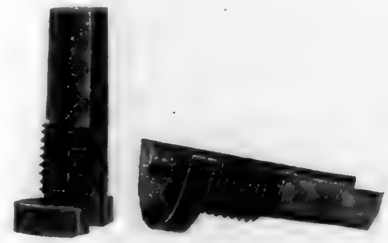
The feeds are driven by a quick and easy cam movement on the large gear, and always take place at the top of the stroke during a very small movement of the ram. The ram guide is fixed in position 15 ins. above the table. The machine will take work up to 48 ins. in diameter. The motor application is especially compact. The motor is of 7½ h.p. capacity and has a speed variation of 3 to 1. With this variation no changes by gearing are necessary. The machine is made at the Niles works of the Niles-Bement-Pond Company.

SAGER AUTOMATIC GRIP DRILL SOCKET.

The Sager automatic grip drill socket was designed to prevent the breakage of the tangs of drills or other taper-shanked tools. It has a powerful grip which tightens automatically on the taper shank and drives the tool with no danger of breaking or twisting off the tang. It may also be equipped with a special or auxiliary sleeve to use drills with broken tangs. Reports from shops using this drill socket indicate a large saving in drills due to its use.

Its construction is simple and it requires no set screws, spanner wrenches, locking sleeves or retaining collars. No machine work is required on the shank of the drill in order to use this socket. To place a drill in the socket it is only necessary to slack off the sleeve three or four turns and insert the drill until it fits loosely against the top of the sleeve. The tang should project far enough above the sleeve to drift it out without touching the sleeve. The sleeve is tightened by hand sufficiently to hold the drill, and it tightens automatically when the drill starts to cut. To release the tool it is only necessary to drift it out in the same manner as with a common drill socket.

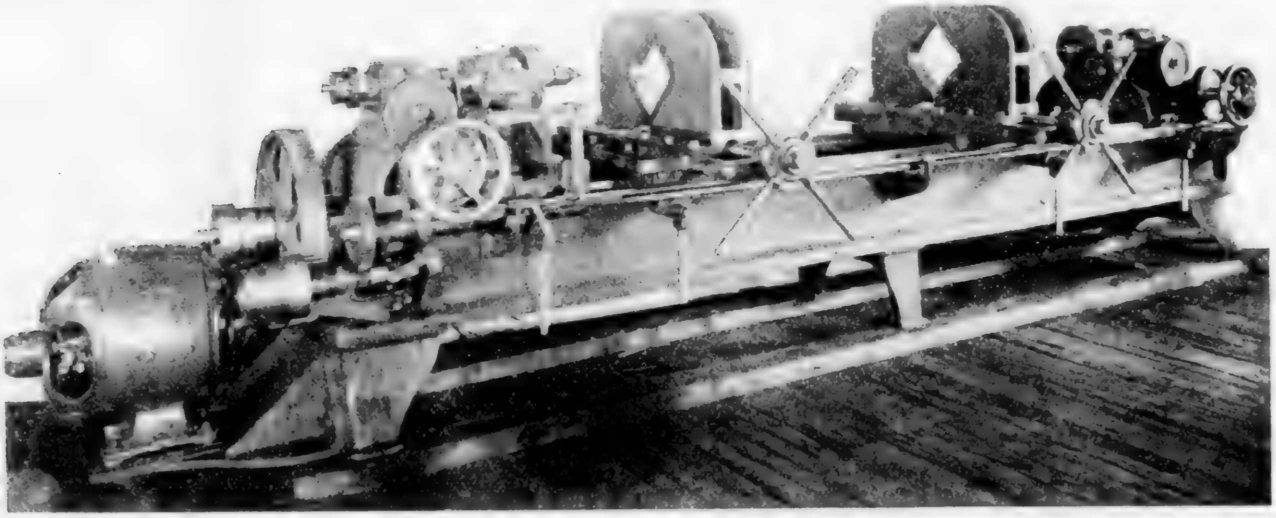
SAGER AUTOMATIC GRIP DRILL SOCKET.



AUXILIARY SLEEVE FOR SAGER DRILL SOCKET.

The grip being positive the drill will not fall through a hole when drilling through boilers or bridges. Special sockets are made for various pneumatic motors and also for spindles of wood-boring machines where set screws are generally used. Several of the large railroad shops are using these drill sockets, which are made by the Sager Drill Socket Company, Albany, N. Y.

MEETING OF THE A. S. M. E.—The Spring meeting of the American Society of Mechanical Engineers will be held at Chattanooga, Tenn., from May 1 to 4. The headquarters will be at the Read House, and the sessions will be held in the assembly hall of that hotel.



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DOUBLE HEAD CENTERING MACHINE.

The double head centering machine illustrated herewith, one of which is in use at the Altoona shops of the Pennsylvania Railroad, is primarily designed for centering locomotive driving axles. It has a capacity up to 8 ft. 6 ins. in length, and the chucks will take axles from 4 to 14 ins. in diameter. The two chucks or vises are self-centering, and are adjustable along the bed. The centering heads are also adjustable along the bed. The spindles of the centering heads have a travel of 5½ ins., and may be operated either automatically or by hand, the large hand wheel in front of the heads being used for the hand feed, while worm wheels are operated by worms on the feed shaft for the power feed.

Above the feed shaft, which is the lower shaft running lengthwise of the bed, is a feed release rod which provides for the automatic release of both centering spindles when they have reached a predetermined depth. The capstan wheels in front of the bed are for closing the chuck jaws. The handles hanging down in front of the heads and chucks are ratchet levers for moving them along the bed. The machine is provided with three feeds, and is driven by a 5-h.p. General Electric 220-volt motor mounted on a bracket bolted to the machine, as shown. The rawhide pinion on the motor shaft meshes with the large spur gear on the machine. The machine, including the motor, occupies a floor space of 4 by 18 ft., and weighs about 10,000 lbs. It is made by The Nazel Engineering & Machine Works, Philadelphia.

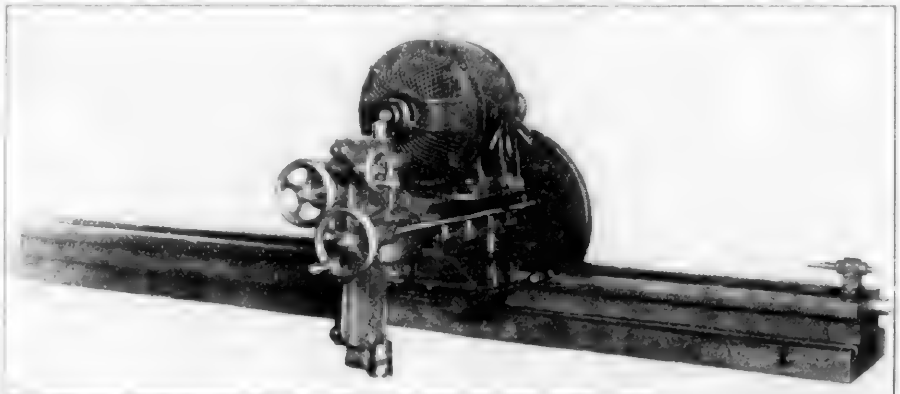
BOOKS.

Valve Gears for Steam Engines. By Cecil H. Peabody. Second edition. Thoroughly revised. 142 pages, 33 folding plates. Published by John Wiley & Sons, New York, 1906. Price, $2.50.

This is a revised edition of the former book by the same author, and is stated to be intended to give engineering students instruction in the theory and practice of designing valve gears for steam engines. The authors aim has been to give the learner a firm grasp of the principles of valve gears and some facility in their application. Each type is illustrated by one or more examples selected from good practice. The book includes careful descriptive matter thoroughly illustrated by drawings of each type of valve gear now in use. All analytical demonstrations relating to principals are given in the appendix. The Zeuner valve diagram is used. Careful attention has been given throughout to make the book simple and easily understood. Problems and their solution are included in each chapter. This book will be found to be of value for reference as well as for instruction.

PORTABLE MILLING MACHINE.

The portable milling machine, illustrated herewith, is designed for work up to 8 ft. in length. As it is motor-driven, it may be taken to the work, and thus can easily do work which could not be handled by other classes of tools. The carriage has a travel of 8 ft. with automatic feed; the cross slide has a movement of 12 ins.; the vertical spindle has a taper hole to receive taper shank mills, and has a movement of 10 ins.; the cross slide has a hand feed. The bed is mounted on a sub-base, and may be accurately adjusted by set screws and taper space pieces, which securely hold the two beds together. The sub-base is fitted with long slots and projections for attaching it to the work by clamps or bolts. This machine has been developed at the works of the Underwood Company, of Philadelphia, and has been added to the line of tools which they manufacture.



UNDERWOOD PORTABLE MILLING MACHINE.

RAILWAY GENERAL FOREMEN'S CONVENTION.

The annual convention of the International Railway General Foremen's Association will be held at St. Louis, Mo., beginning Tuesday, May 8th, at 10 a. m. All sessions will be open to those interested in the mechanical department of railway service. Those eligible to active membership are: General foremen, superintendents of shops, division foremen, machine foremen, roundhouse foremen and assistants of railway locomotive repair shops. Applicants can be recommended by an active member or master mechanic, or superintendent of motive power. The Jefferson Hotel has been chosen as the official headquarters.

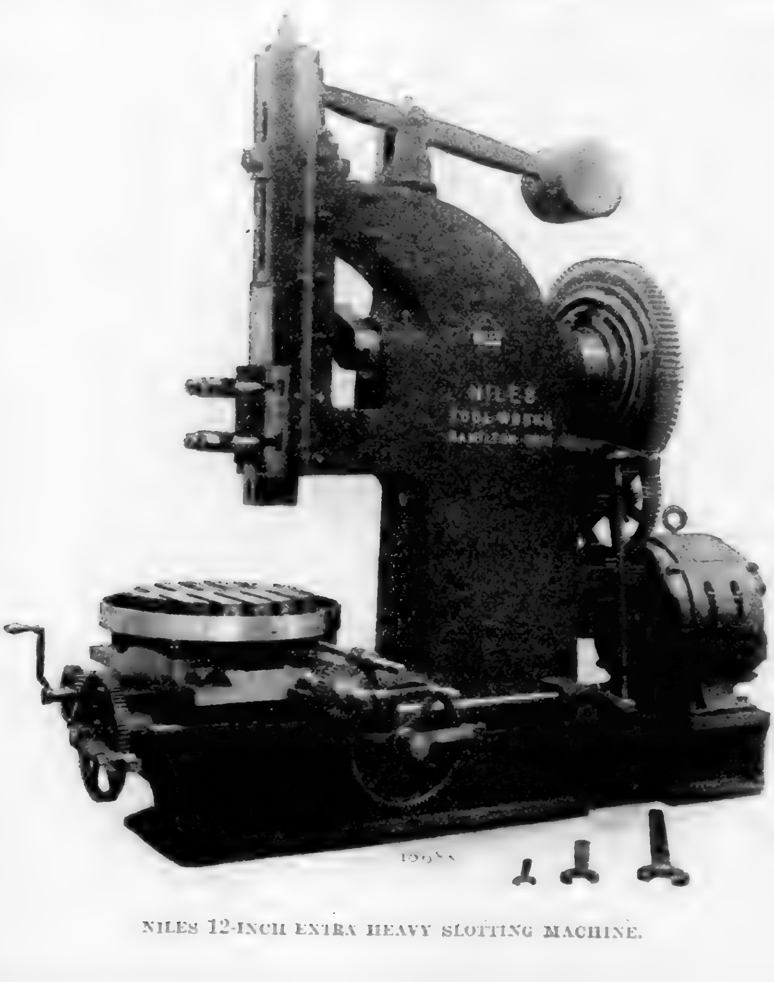
The following is the list of topics to be discussed: 1. How can we best organize to take every possible advantage of convention opportunities for the interchange of ideas and the

promulgation of the most advanced methods of shop procedures and discipline? Legitimate reasons why an organization of foremen should exist—Our aims and educational possibilities presented.—Paper by D. E. Barton. 2. Modern Machine Shop Practice. Its economic phase to include a statistical comparison with the year 1895.—Paper by Lee R. Laizure. 3. The Duties of the Foremen. Their relation to each other. The advisability of weekly or semi-monthly meetings of the shop foremen. The necessity for mechanical literature to the end that we keep in touch with the world of mechanics.—Paper by G. W. Keller. 4. Broken Frames. Which is the best method of welding a broken frame, by the use of Thermit or to take down and weld in the blacksmith shop?—Paper by C. H. Voges. 5. Pooling Engines. Do we get as good results by pooling engines as we do by having regular crews on them?—J. C. Wilkinson, chairman. 6. Electric Lights. What advantage has an electric light over the oil light, taking into consideration the expense of keeping it up and the effect it has on the eyes of the engineer?—A. S. Abbott, chairman. 7. Motive Power by Electricity. What relation will electricity have to the motive power on the railroads in the next ten years? Will it ever supersede steam, and will it ever be a success?—L. H. Raymond, chairman. 8. Cause of Leaky Flues. What causes leaky flues? Is it the handling of the engine, or the water used, or is it the workmanship?—B. E. Greenwood, chairman. 9. Qualities of a First-Class Roundhouse and Division Foreman.—Paper by G. H. Gates. 10. Pooling of Engines. Its mechanical and financial aspect.—Paper by W. H. Graves.

12-INCH SLOTTING MACHINE.

This is an extra heavy machine designed especially for forge work. The ram is provided with removable tool clamps on the front face and with a relief tool holder on the end. The crank is forged in one piece with the driving shaft. The ram and crank are both corrugated under the connecting rod washers to avoid slipping. The driving shaft has the Whitworth quick return motion with a large cone and driving gear. The work table is 26 ins. in diameter, has 18-in. longitudinal and 18-in. cross motion, and has a water channel all around.

The feeds are driven by a quick and easy cam movement on the large gear, and always take place at the top of the stroke during a very small movement of the ram. The ram guide is fixed in position 15 ins. above the table. The machine will take work up to 48 ins. in diameter. The motor application is especially compact. The motor is of 7½ h.p. capacity and has a speed variation of 3 to 1. With this variation no changes by gearing are necessary. The machine is made at the Niles works of the Niles-Bement-Pond Company.



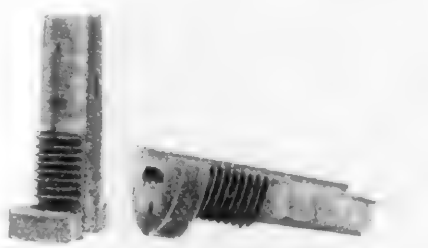
NILES 12-INCH EXTRA HEAVY SLOTTING MACHINE.

SAGER AUTOMATIC GRIP DRILL SOCKET.

The Sager automatic grip drill socket was designed to prevent the breakage of the tangs of drills or other taper-shanked tools. It has a powerful grip which tightens automatically on the taper shank and drives the tool with no danger of breaking or twisting off the tang. It may also be equipped with a special or auxiliary sleeve to use drills with broken tangs. Reports from shops using this drill socket indicate a large saving in drills due to its use.

Its construction is simple and it requires no set screws, spanner wrenches, locking sleeves or retaining collars. No machine work is required on the shank of the drill in order to use this socket. To place a drill in the socket it is only necessary to slack off the sleeve three or four turns and insert the drill until it fits loosely against the top of the sleeve. The tang should project far enough above the sleeve to drift it out without touching the sleeve. The sleeve is tightened by hand sufficiently to hold the drill, and it tightens automatically when the drill starts to cut. To release the tool it is only necessary to drift it out in the same manner as with a common drill socket.

SAGER AUTOMATIC GRIP DRILL SOCKET.



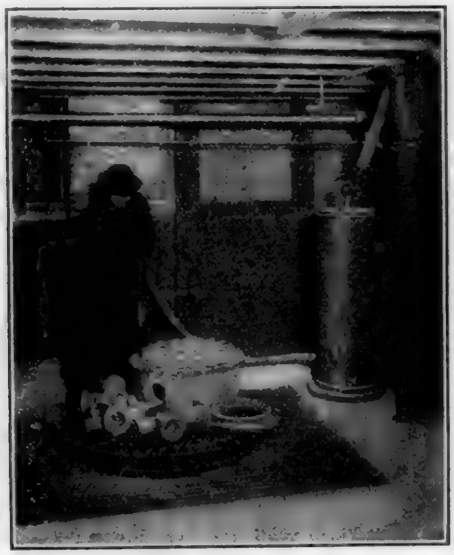
AUXILIARY SLEEVE FOR SAGER DRILL SOCKET.

The grip being positive the drill will not fall through a hole when drilling through boilers or bridges. Special sockets are made for various pneumatic motors and also for spindles of wood-boring machines where set screws are generally used. Several of the large railroad shops are using these drill sockets, which are made by the Sager Drill Socket Company, Albany, N. Y.

MEETING OF THE A. S. M. E.—The Spring meeting of the American Society of Mechanical Engineers will be held at Chattanooga, Tenn., from May 1 to 4. The headquarters will be at the Read House, and the sessions will be held in the assembly hall of that hotel.

COMPRESSED AIR SAND BLAST MACHINE.

The cleaning of metallic sufaces by means of the sand blast is coming to be recognized as the most satisfactory and cheapest method. Its field of usefulness is being extended gradually until it is now covering the cleaning of both forgings and castings, as well as sheet and structural metal.



CLEANING CASTING WITH SAND BLAST MACHINE.

The uses that sand blasting has been put to in railroad shops have usually employed a crude and more or less inefficient apparatus of local make. However, as a broader field is developed, an apparatus of this nature is unsatisfactory and a more efficient and a machine less costly to operate is demanded.

The illustration herewith shows the sand blast apparatus furnished by the Tilghman-Brooksbank Sand Blast Company of 1126 South Eleventh Street, Philadelphia, Pa., who are probably the oldest firm in this field, having been established over twenty-five years. The sand blast machine shown uses compressed air at a pressure of from 10 to 20 lbs. per sq. in. to propel the sand and has a long flexible hose, permitting a wide radius of action. The machine itself consists of a steel drum, in the upper part of which is the sand reservoir and in the lower the mixing chamber. Suitable valves are furnished for gauging the supply of air and the proper mixture of sand, and a gauge on the air supply line indicates the pressure being used. A covered hand-hole in the side is so situated that all valves and parts subject to wear are easily accessible. All of the parts of the machine which are subjected to wear are made extra heavy, long experience having shown the weak points and how to correct them. The machines are made in four different sizes, using volumes of free air varying from 35 to 280 cu. ft. at 10 lbs. air pressure.

COST OF OPERATING A RAILWAY.—The following figures are taken from the annual report of an American railway operating 739 locomotives over 1,500 miles of track, the total engine mileage of all kinds being nearly 26,000,000: Repairs to locomotives, $1,280,000; repairs to freight cars, $1,238,000; wages to enginemen, $1,826,000; fuel for locomotives, $2,684,-000; repairs and renewals to shop machinery, $181,000, and water supply for locomotives, $176,000.

AMERICAN LOCK NUT.

The demand for a successful and positive nut lock for use in the different departments on railroads has been very insistent. The difficulty and cost of discovering and tightening loose nuts on important bolts in locomotive and car work alone is recognized by all motive power men, and in addition to this the track department has similar troubles.

There are on the market a large number of devices or special arrangements for preventing nuts from turning on the bolt after they are once in place and locked which seem to cover every plausible scheme for accomplishing this desirable result. Some of these have proved practical successes and others have not.

In the former class may be included a very simple device, which is shown in the illustrations herewith. This is made by the American Lock Nut Company, 134 Congress Street, Boston, Mass., and consists of a small key of tempered steel, which is fitted into a radial slot cut in the thickest part of the top of the nut. The slot and key are of such shape that the key can be rocked; swinging on a slight projection at the bottom, and either have its edge forced into the thread of the bolt when in the locked position or can entirely clear the threads when in the unlocked position. The top of the slot in the nut is so compressed on each side against the beveled edges on the top of the key that the latter is prevented from coming upward and out of the slot, but its free movement is not obstructed. With this device, after the nut is tightened in place, a small punch is placed on the inner end of the key as shown by the arrow "to lock" and a blow forces the cutting edge downward into the threads of the bolt in a manner which makes it impossible for the lock to have any tendency toward working loose. However, if it is desired to remove the nut a similar blow on the outer edge of the key easily and quickly rocks it backward and allows the nut to be removed with a wrench without damage to itself or to the threads of the bolt. The nut used with these locks is the usual commercial nut unless otherwise specified and does not differ from the standard nuts in use in shape or size. The life of the lock is fully equal to that of the nut which can be used over again repeatedly.

PERSONALS.

Mr. C. L. Meister has been appointed mechanical engineer of the Atlantic Coast Line Railroad.

Mr. C. E. Turner has been appointed superintendent of motive power of the Coal and Coke Railway.

Mr. George W. Smith has been appointed division master mechanic of the Wabash Railroad at Fort Wayne, Ind.

Mr. William J. Coakley has been appointed traveling engineer of the entire Cincinnati, Hamilton & Dayton system.

Mr. G. W. Seidel has been appointed superintendent of the East Moline shops of the Chicago, Rock Island & Pacific Railway.

Mr. E. J. Davis has been appointed master mechanic of the Washington, Idaho & Montana Railroad, with headquarters at Palouse, Wash.

Mr. George W. Stillwagon, general car foreman of the Pittsburg, Shawmut & Northern Railroad, has been appointed master car builder.

Mr. S. G. Wise has been appointed assistant road foreman of engines of the Middle division Pennsylvania Railroad, with headquarters at Hollidaysburg, Pa.

Mr. Oscar Dunton, Providence, Ky., is master mechanic of the Kentucky Valley Railroad, which has been completed and was put into operation on March 14th.

Mr. Henry M. Etchison has been appointed librarian of the Baltimore & Ohio Railroad at the Mt. Royal Station, Baltimore, Md., vice A. M. Irving, deceased.

Mr. C. D. Kunerth has been appointed general foreman of the Chicago, Rock Island & Pacific Railway at Herington, Kans., to succeed Mr. Wm. Evans, resigned.

Mr. J. C. Brackenridge has been appointed consulting engineer, in connection with electrification on the New York Central & Hudson River Railroad.

Mr. A. H. Hodges has been appointed general foreman of the Baltimore & Ohio Railroad at Brunswick, Md., to succeed Mr. Z. T. Bradtner, transferred to other duties.

Mr. R. C. Burns, assistant car inspector for the Pennsylvania Railroad at Altoona, has been appointed general car inspector, to succeed Mr. J. K. Roush, deceased.

Mr. J. C. Homer has been appointed master mechanic of the Cincinnati, Hamilton & Dayton Railroad, at Indianapolis, with jurisdiction over the I., D. & W. division.

Mr. J. P. Calligan, mechanical engineer of the Texas & Pacific Railroad at Marshall, Texas, died on March 20th from the accidental discharge of a gun while hunting.

Mr. H. L. Leach has been appointed assistant superintendent of motive power and equipment of the Bangor & Aroostook Railway, with office at Houlton, Me.

Mr. P. F. Risteen, mechanical superintendent of the eastern division of the Atchison, Topeka & Santa Fe Railway, died at his home in Topeka, Kansas, on March 26, 1906.

Mr. Frank P. Roesch, formerly master mechanic of the Chicago & Alton Railway, has been appointed master mechanic of the Southern Railway at Birmingham, Ala.

Mr. David H. Wilson, Jr. has been appointed electrical engineer for the Erie Railroad, in charge of the power plants and other electrical equipment along the entire system.

Mr. M. D. Stewart has resigned as superintendent of motive power of the Chicago, Peoria & St. Louis Railway, to become connected with the Fitz-Hugh, Luther Company, Chicago.

Mr. W. J. Collins, general foreman of shops of the Chicago, Burlington & Quincy Railway, with headquarters at St. Louis, has resigned to accept a similar place with the Wabash Railroad.

Mr. E. F. Needham, heretofore division master mechanic of the Wabash Railroad at Fort Wayne, Ind., has been appointed division master mechanic at Springfield, Ill., succeeding Mr. C. H. Doebler, resigned.

Mr. E. J. Smith, heretofore master mechanic of the Atlantic Coast Line at High Springs, Fla., has been appointed assistant superintendent of motive power of the third division of that company, with office at Jacksonville, Fla.

Mr. A. L. Rossetter, heretofore master mechanic of the Chicago, Peoria & St. Louis Railway, has been appointed superintendent of motive power, and Mr. W. T. Cousley, master car builder, with headquarters at Springfield, Ill.

Mr. R. G. Long, general foreman of the Missouri Pacific at Fort Scott, Kans., has been appointed division master mechanic of the St. Louis, Iron Mountain & Southern Railroad at McGehee, Ark., in place of Mr. A. McCormick, resigned.

Mr. J. H. Wynne has resigned as mechanical engineer of the Illinois Central R. R. to accept the positon of western manager of the Atlantic Equipment Company, with headquarters at Chicago. He will also represent the American Locomotive Company.

Mr. W. F. Buck has been appointed mechanical superintendent of the Eastern Grand Division of the Atchison, Topeka & Santa Fe at Topeka, Kansas, to succeed Mr. F. N Risteen, deceased. Mr. Buck was formerly master mechanic of the Santa Fe Coast Line at Needles, Cal.

Mr. J. E. Keegan, heretofore master mechanic of the Grand Rapids & Indiana R. R., has been appointed superintendent of motive power, with headquarters at Grand Rapids, Mich. Mr. J. F. Hayes has been appointed master mechanic, with office at Grand Rapids, to succeed Mr. Keegan.

Mr. G. M. Brill, the well-known head of the J. G. Brill Company, died of apoplexy at his home in Merion, Pa., on March 31st. Mr. Brill was 62 years of age and had followed the business of constructing street cars from early manhood, building up one of the largest and best companies in the country.

Mr. C. K. Shelby, assistant engineer of motive power of the Pennsylvania Railroad and the Northern Central at Williamsport, Pa., has been appointed master mechanic of the latter road at Elmira, N. Y., succeeding Mr. John M. Henry, who has been appointed master mechanic of the Pennsylvania at Sunbury, Pa. Mr. J. L. Cunningham has been appointed to succeed Mr. Shelby as assistant engineer of motive power at Williamsport.

Following the promotion of Mr. H. M. Carson, superintendent of motive power of the Pennsylvania Railroad at Buffalo, N. Y., to be assistant to the general manager, Mr. R. K. Reading has succeeded Mr. Carson as superintendent of motive power at Buffalo, N. Y., and Mr. D. M. Perine has been appointed superintendent of motive power on the Philadelphia & Erie and Northern Central; Mr. J. T. Wallis, master mechanic at West Philadelphia, and Mr. J. C. Mingle, master mechanic, at Baltimore, Md.

Mr. Robert Miller died at his home in Detroit on March 13th. Mr. Miller entered the service of the Chicago, Burlington & Quincy Railroad in 1859 as a journeyman carpenter, and when the war broke out he enlisted in Company E, Eighty-ninth Illinois, which was known as one of the "railroad" regiments. He was successively promoted from the ranks to first lieutenant and was mustered out in 1865. He then went back to the C. B. & Q. R. R., remaining with the road until 1876, when he became master mechanic of the Michigan Central. Following this he became assistant general superintendent, general superintendent and was finally appointed superintendent of motive power and equipment, which position he held until 1900, when he retired from active business duties.

CATALOGS.

IN WRITING FOR THESE, PLEASE MENTION THIS PAPER.

Rock Crushing Machinery.—The Power & Mining Machinery Company, Cudahy, Wis., is issuing catalog No. 4, which describes and illustrates the McCully gyratory rock crusher, as well as hoists, dump cars, conveyor belts and other rock crushing appliances.

G. E. Fan Motors.—The General Electric Company, Schenectady, N. Y., is issuing a catalog which thoroughly describes and illustrates the different types of electric fans and the motors which drive them, the latter being shown in detail. These include many new arrangements for electrc fans.

Out-door Cranes.—The Niles-Bement Pond Company, 111 Broadway, New York, is issuing a catalog which shows by means of illustrations of recent applications the many different types of cranes for out-door service which are manufactured by it. A very wide range of application is shown in the illustrations

Cold Saw Cutting-off Machinery.—The Newton Machine Tool Works, Philadelphia, Pa., is issuing a catalog which illustrates by means of views and line drawings a large variety of cold saw cutting-off machines, which are arranged for work on many different shapes. Vertical and horizontal machines are shown.

Screw Wrenches.—The Coes Wrench Company, Worcester, Mass., is issuing an attractive catalog which illustrates and describes the different types of screw wrenches manufactured by this company, which started the manufacture of wrenches in 1843, and has given the subject probably closer and longer study than any other single firm

Corundum Wheels.—The Star Corundum Wheel Company, Ltd., of Detroit, Mich., is issuing catalog No. 8, of standard size, containing over 100 pages in which are illustrated and described an exceedingly wide range of shapes and sizes of grinding wheels made of both emery and corundum, as well as grinding machines, grinding appliances, oil stones, etc.

Ratchet Jacks for Cars and Tracks.—The Buda Foundry & Mfg. Company, Railway Exchange, Chicago, is issuing a catalog which illustrates and briefly describes the many different kinds of ball-bearing rachet jacks for use in different kinds of service, manufactured by it. In connection with each jack a table of numbered parts giving the prices for each piece is shown.

Tests of Dixon's Flake Graphite.—In the April issue of "Graphite" is given an account of a test, made by Professor Goss of Purdue University, of Dixon's flake graphite as a lubricant. The tests were made between a lubricant of clear kerosene and mixtures of graphite and kerosene. The addition of the graphite permitted the load to be increased 120 per cent., and gave a reduction in the co-efficient of friction of 45.9.

Brake Hanger.—The J. J. Brill Company, Philadelphia, is issuing a catalog which thoroughly illustrates and carefully describes the new Brill noiseless brake hanger, which is arranged to use a ball and socket joint at the brake head. In this the cap socket is always held firmly on the ball by a wedge which is advanced by a pair of springs as the socket becomes worn. This equipment is all included in the brake head and forms a hanger which is practically noiseless.

Spring Painting.—The Joseph Dixon Crucible Company, Jersey City, N. J., is issuing a leaflet which sets forth the advantages of the Dixon-silica graphite paint for use on both wood and metal work. This paint has been in successful use for over 40 years and has proven itself to be an exceptionally good protection from either weather or gases.

Westinghouse Fan Motors.—The Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., is issuing a catalog which shows by means of illustrations of installations, as well as illustrations of the different types of fans themselves, all of which are briefly described, a large assortment of desk, bracket, ceiling and floor fans using either direct or alternating current. In the same catalog is also included descriptions of small motors for either direct or alternating current ranging in power from 1/20 to 1/8 h.-p. Price lists are given.

Horizontal Engines.—The B. F. Sturtevant Company, Hyde Park, Mass., has issued bulletin No. 131 of its engineering service, which describes the Sturtevant horizontal centre crank engines. These engines are designed particularly for the driving of direct connected generators, and can also be used successfully as independent engines. The illustrations show the main parts and important details, as well as the completed engine. A table showing net horse-powers with different sizes of these engines operated under different steam pressures is given.

NOTES.

Structural Steel Work.—The Pennsylvania Railroad Company has awarded a large tonnage of structural steel work for use on the improvements and new station at East Pittsburg, Pa., to Wm. B. Scaife & Sons Company, of Pittsburg, Pa.

Westinghouse Electric & Manufacturing Company.—The erecting department of this company, for Manhattan Borough which has been located on the 19th floor of the Trinity Building, has been removed to the Fuller Building, Twenty-third Street and Broadway, New York City. This change was made necessary because of the need of more space.

Flannery Bolt Company.—Notice has been sent out that Mr. W. M. Wilson has been appointed western representative with office at Chicago, and Mr. Tom R. Davis has been appointed mechanical expert and traveling representative of the Flannery Bolt Company of Pittsburg, which manufactures the Tate flexible staybolt.

Ingersoll Rand Company.—Mr. C. Frank Schwep has been appointed general purchasing agent of this company at 11 Broadway, New York. Mr. Schwep has been at the head of the purchasing department of the Ingersoll-Sargent Drill Company for the past thirteen years, and was located at the shops at Easton, Pa., and Phillipsburg, N. J.

Westinghouse Machine Company.—This company received orders during the month of March and February for 35 steam turbines, aggregating approximately 50,000 brake h.-p. capacity. The largest of these was of 7,500 k.w. or 11,000 brake h.-p. capacity, which will be installed by the Transit Development Company of Brooklyn. The other machines were for use in different parts of the country.

Compressed Air.—It is announced that beginning with its issue of May "Compressed Air" will appear in enlarged form and under new management Hereafter it will be published by the Kobbe Company, 90-92 West Broadway, New York. Founded ten years ago, it is the only publication devoted exclusively to the field of compressed air in all its applications. W. L. Saunders will remain as editor-in-chief, W. R. Hulbert will be managing editor and P. F. Kobbe, Jr., will be business manager.

Manufacturers' Advertising Bureau.—This bureau, which was established in 1877, has for some time found its Liberty Street offices too small for its increasing business and it is now removed to 237 Broadway, New York City. The bureau intends to broaden the scope of its work, and, while particular attention will be given to advertising in the trade and technical journals as heretofore, it will also be equipped to handle advertising in newspapers, magazines and other periodicals.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL

JUNE, 1906.

THE MECHANICAL DEPARTMENT HAS A FUTURE.

By G. M. Basford.

"The colleges do some good—they keep some of the lightweights out of the railroad business." This cynical remark by Hiram Bolton in the "College Widow" suggests a question which is rather important at the present time. This is: How shall the bright young man get into the railroad business? Another is: How shall he be kept in the railroad business?

Railroad work presents too many distinct fields to permit of any general statement which will cover them all, but some remarks concerning the motive power department as a field for young men seem to be necessary just now.

At this time of year it is not unusual to find posted on the bulletins of the various technical schools, giving especial attention to engineering work, a number of letters from large industrial establishments and railroads indicating a desire to secure college men for subordinate positions, incidentally implying most brilliant promises for the future. The boys are stirred up by these prospects; they are anxious to start in the game of life, and at this point they are in great danger of being wrongly impressed with their importance. They are led to believe that the world has been expecting them for some time and is ready to offer most extraordinary advantages, from which they have only to select the best in order to be sure of success. Some of these bulletins are followed up by representatives of the companies, bringing lantern slides, and even moving pictures, showing the interesting character of the work which the young recruits take up, and these representatives have been known to promise certain definite salaries at the end of specified periods.

The young men are misled. They get a wrong idea of life from the large number of invitations presented just at this impressionable stage, and they are likely to believe that the education which they have just "completed" is to keep before them always a large number of brilliant opportunities from which they have only to select the best, as they may at the outset. As a matter of fact, no such array of opportunities ever appears before the college man at any other period in his career after he once gets to work—at least it never comes until the young man's record has been made by his work, so that he is widely known to be able to do certain things which people want done.

Nearly all of the concerns and railroads offer the young men what is called "Special Apprenticeship." This is believed to be a mistake, and the present situation of college men on railroads would seem to be abundant evidence that a better way is needed to bring these young men into contact with the railroad problem. Other reasons why it is a mistake have been presented in these columns, but it is sufficient to say that this method discourages the young men by placing them at a disadvantage because of a lack of experience involving personal responsibility. That, alone, is enough to suggest seeking after an improved method. "Special apprenticeship" is too slow. It tends towards superficial experience. A "special" apprentice does not encounter responsibility at the beginning, and, at the end of a period of perhaps three years it is necessary for him to again begin at the bottom.

There never was a period in the history of the railroads when experienced and well-prepared young men were as greatly needed in the motive power department as they are to-day. There never was a time when so many important problems confronted the man capable of contributing to the development of the locomotive. When in the past have so many questions, as—the big locomotive, compound locomotives, stokers, superheating, balancing, improved valve gear, articulated construction, feed water heaters, variable exhaust nozzles, combustion chambers, motor cars, and the various shop problems of the present time, faced the railroad officer? And at what period of the past has development been so rapid as it is at the present time? One who attempts to analyze the motive power possibilities and the opportunities of the motive power officer to aid in the great problem of transportation, will be convinced of the fact that the motive power officer of the future must be a bigger man than the one of the past, because, thus far, only the surface of the possibilities has been scratched. The motive power officer has not yet begun to show how he can affect the efficiency of operation.

This means that the railroads will need to develop young men as rapidly as possible; and, if the time-honored methods of recruiting them have proved to have failed—as they seem to have done—it is time that something better was tried. The simplest way, and the one which seems to promise most, is to take young men from college into the service as workmen, allowing them to carve their own way from the very first, insisting that as far as possible only those will be taken into regular service who have had some practical shop experience. (Even that which may be obtained during vacations is a great help.) By putting these young men upon their own responsibility at the outset they will develop with the greatest possible rapidity.

The college professors of the present time may be said to feel doubtful of railroad work as a promising field for their product—and, after looking over the situation carefully, they cannot be blamed for this opinion which is rapidly becoming a conviction. Undoubtedly improved methods may be introduced for starting the young men in their careers, but it is equally important that improved methods be adopted for retaining them. Once these young men are in the service the real trouble begins, because their value increases so fast as to render it difficult to keep them in the service.

The matter of compensation is large enough for a discussion of its own. It is sufficient to say that the railroads should offer a living wage to the young men and that the young men should be glad to secure a living wage. They should then be advised not to think of the matter of compensation until after several years—say—five years, of service. After that time, they have usually had a most excellent experience and are wanted by every sort of industrial establishment because of the valuable experience which the railroad service has given them. At such a time a little encouragement is necessary, and there should be someone in the mechanical department of the railroad who has time to give it. Many young men have gone into the most difficult part of the motive power field—the round house—and have served faithfully for a sufficient length of time to fix their value to the road and have then been enticed away because of the apparent lack of future and because of inducements offered elsewhere. There really is no lack of future on a railroad for those who are content to wait and who occupy themselves in the right way while they wait. But, it is a fair question to put to any railroad official—whether the apparent outlook for a young college man who has "made good" in the management of men in such a difficult position as that of a round house foreman, is sufficiently bright to lead him over the critical period which precedes the real beginning of his advancement. Once past the round house stage, the young man may by careful treatment, be permanently preserved to the service; and it is right at this point of his experience that he needs the encouragement which he would receive in being assured that he has a future on the road.

The young men are a little too impatient. They, as a rule, need the advice of someone to whom they will listen and

who will tell them to be patient. The college professor needs the co-operation of railroad officials so that the preparation of the students may be intelligently conducted. And, the railroads need to be shown that in the future they are going to need technical men more than they have in the past and that the interest in railroad work will not, of itself, attract young men or hold them against the competition of industrial establishments where they appear, at the present time, to be better appreciated.

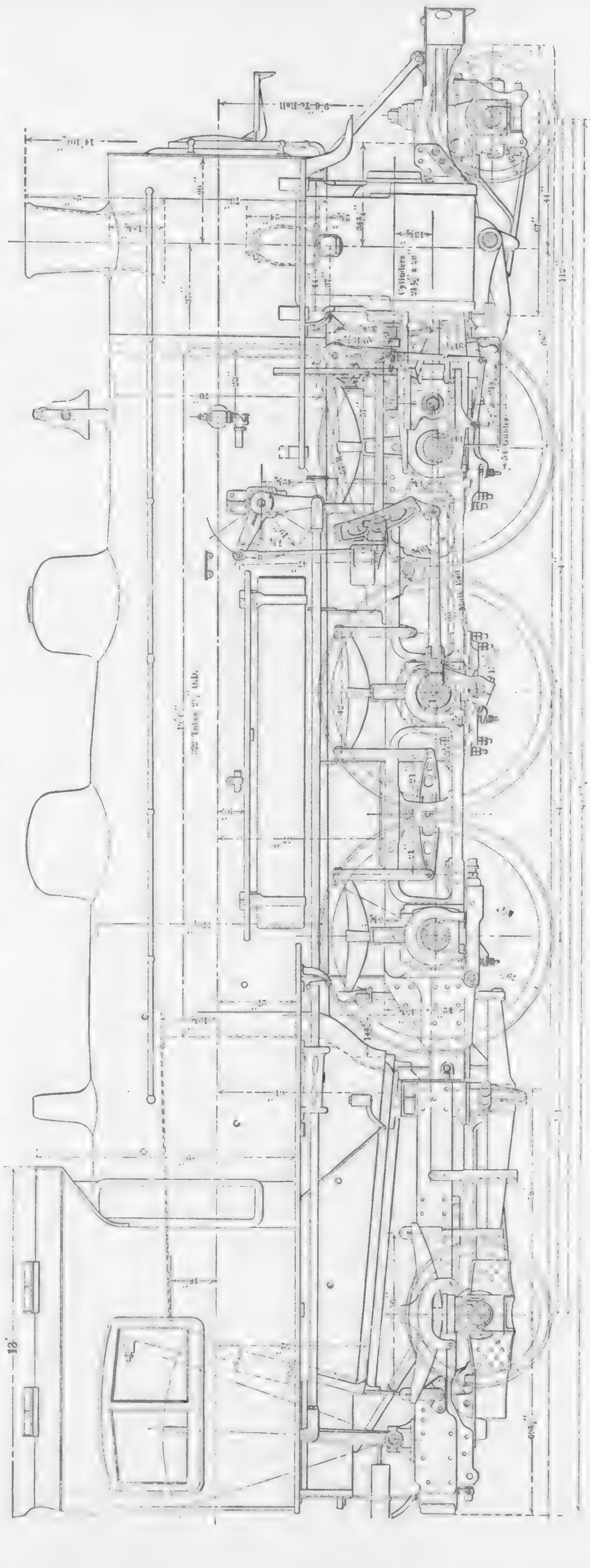
The young college men who enter railroad work with the determination to see it through, and who are patient enough to stick until they are absolutely required—as they will be—for important positions, will, themselves, improve these conditions. There is no better field to-day for the young man who is mechanically inclined and can manage men than the motive power field, and none in which better records are to be made by young men who are properly prepared to make them.

The young men who are prepared to "butt in" and "look for trouble" and who appreciate the importance of preparation coupled with patience are sure to be glad that they entered railroad service. In time, they will, themselves, exert a powerful influence in removing the difficulties and discouragements which now surround the motive power officer.

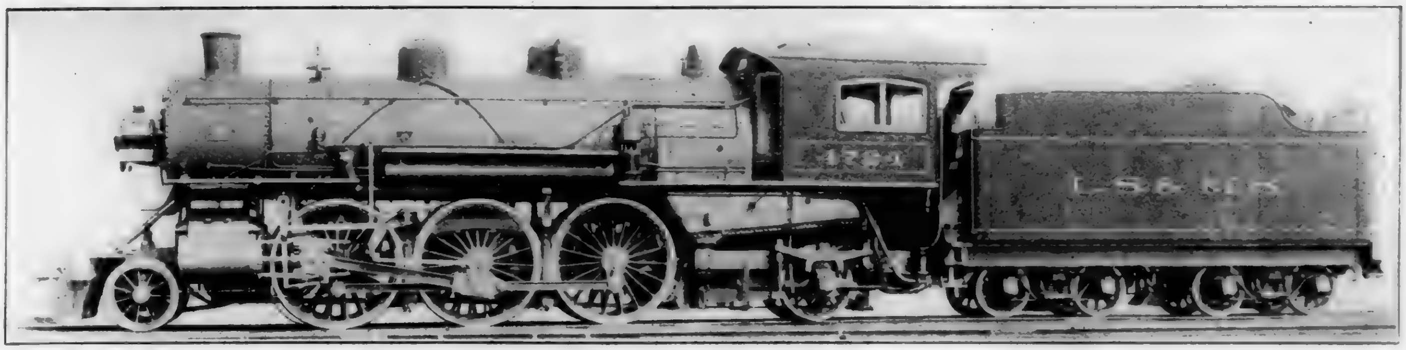
THE SUCCESSFUL FOREMAN.—To sum up—the successful general foreman must be a hustler, a man who can enthuse life into his foremen so that they will keep their shoulders to the wheel and keep things moving. The most skilful foreman is not always the one that has exceptional mechanical ability. While exceptional mechanical ability is desirable, it is also necessary that a foreman be able to take a bird's-eye view of the situation. A man is needed who can keep the continuity of the work in his mind and bring the various factors together, so that they will work out harmoniously, both as to construction and time. This qualification is especially desirable when one foreman's work is dependent upon another's. The foreman who possesses these qualifications can truly be said to be successful.—*Mr. Lee R. Laizure, International Railway General Foremen's Association.*

COST OF REPAIRS PROPORTIONAL TO ORIGINAL COST.—My experience is that engines cost to repair in similar service, very nearly in proportion to their original cost or to the traffic they handle —it does not make much difference. We keep a $10,000 locomotive in repair at 4 cents per mile. We can keep $10,000 worth of freight cars in repair at 4 cents a mile. The rule may not always hold, but it comes to about the same thing. Equipment of the same value will cost about the same to keep up, and it does not seem to me that electrical equipment is going to be very much different.—*H. H. Vaughan, New York Railroad Club.*

COMPOUND FREIGHT LOCOMOTIVES.—It seems to me, aside from any question of fuel economy, cost of repairs or reliability, the fact that a fireman can come nearer making a heavy compound engine haul its calculated rate than he can a simple, is sufficient argument for compounding heavy freight engines.—*D. Van Alstyne, before the Western Railway Club.*



SIMPLE PRAIRIE TYPE PASSENGER LOCOMOTIVE.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



HEAVIEST PASSENGER LOCOMOTIVE, LAKE SHORE & MICHIGAN SOUTHERN RY.

PRAIRIE TYPE PASSENGER LOCOMOTIVE WITH WALSCHAERT VALVE GEAR.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

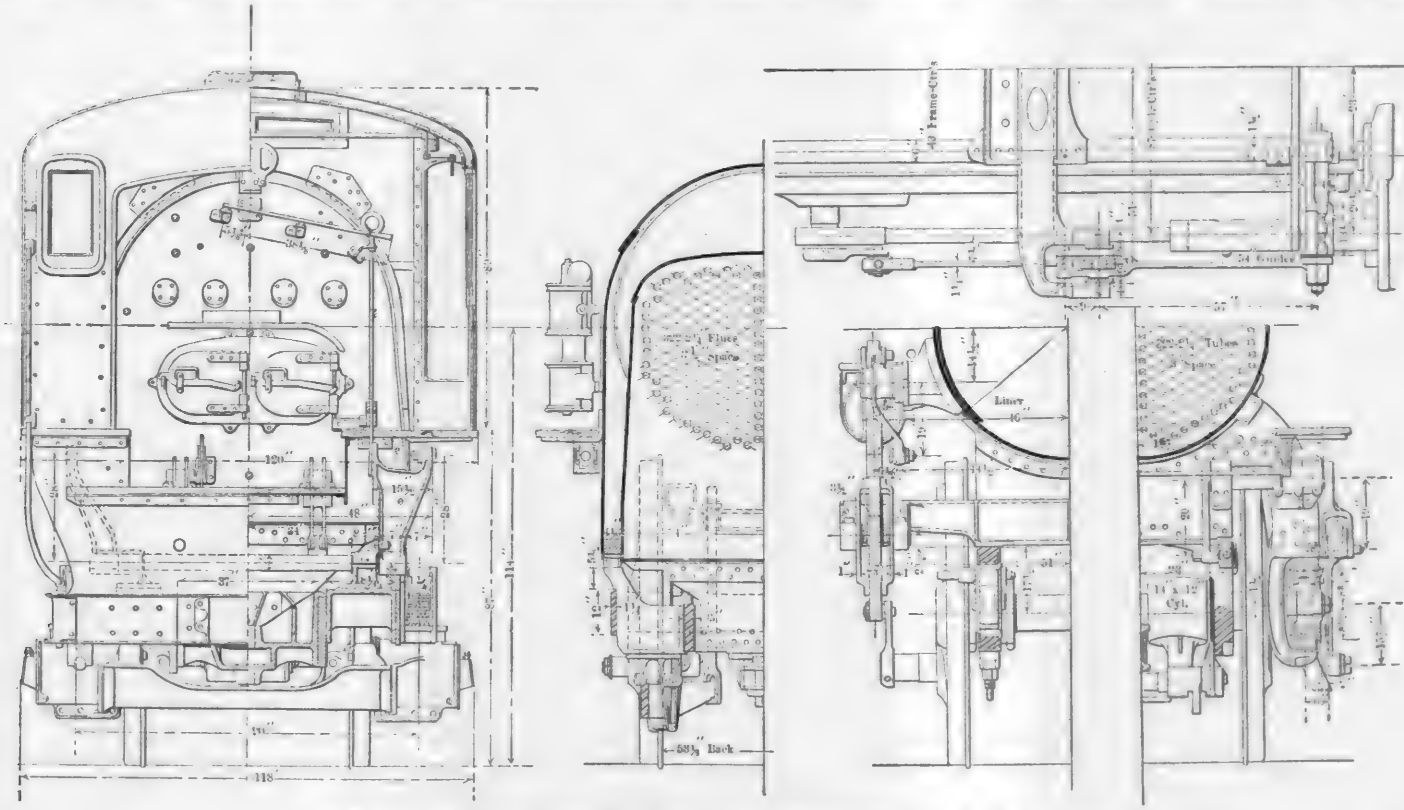
About a year and a half ago the Lake Shore & Michigan Southern Railway put into service some very powerful and incidentally handsome locomotives of the Prairie type, which were at that time the heaviest passenger locomotives ever built. These engines were thoroughly illustrated and described in the AMERICAN ENGINEER AND RAILROAD JOURNAL, November and December, 1904, and January, 1905.

Recently it has become necessary to order more locomotives of this type, and in view of the excellent satisfaction which had been given by the previous engines, it was decided to practically duplicate that design in essential details, and an order was given to the American Locomotive Company for the engines, which are illustrated herewith, and which, in regard to total weight and weight on drivers, are the heaviest passenger locomotives that have ever been constructed, weighing, as they do, nearly 245,000 lbs. total and 170,000 lbs. on drivers.

This order forms the third class of Prairie type engines in use on this road for fast passenger service, the first of which were put into service early in 1901. Each new class has been designed in view of the experience with the previous one, and it speaks exceedingly well for those already in use that it has been found necessary to make so few changes in this last order. The following table shows the general dimensions of each of the three, as well as the ten-wheel passenger engine which immediately preceded them:

	F-52	J-40	J-41	J-42
	4-6-0	2-6-2	2-6-2	2-6-2
Total weight	172,500	174,500	233,000	244,700
Weight on drivers	135,000	130,000	165,200	170,000
Tractive effort	23,500	24,700	27,850	27,850
Size cylinders	20 x 28	20½ x 28	21½ x 28	21½ x 28
Dia. drivers	81	81	79	79
Total heating surface	2862.5	3,362	3,905	3,905
Grate area	36.6	48.6	55	55
Reference in American Engineer	1899 p. 343	1901 p. 69	1904 p.413	1906 p. 203

The principal changes which have been made in the former design are the application of the Walschaert valve gear in place of the Stephenson, and the use of a radial outside bearing trailer truck. This company has had considerable experience with Walschaert valve gear in freight service, it being the pioneer in the use of this design, which is now becoming very popular in this country, and this experience has been so satisfactory that it was decided to extend its use to passenger locomotives. In making the application it was necessary to rearrange but a small number of parts in the previous design, and the cylinders, guide yoke and guides were allowed to remain as they were, a separate steel casting being designed to span the frame between the first and second pair of drivers and support the link of the Walschaert gear. Inasmuch as a valve chamber over the frames is used, it was necessary to transmit the motion to a rocker placed on the frame just behind the cylinders and operating the valve stem through a crosshead connection. The bell crank used for re-



SECTIONS AND VALVE GEAR, PRAIRIE TYPE LOCOMOTIVE, L. S. & M. S. RY.

versing is fastened to the boiler shell with the vertical arm extending downward and connecting to the reverse shaft by a reach rod. Part of these engines have the reverse shaft in its usual location, between the second and third pair of drivers, and part of them with it across the frames at the rear of the firebox, in which case there are two reach rods extending forward.

The design of the outside bearing trailer truck, which employs two slab frames at the rear, one inside and one outside the wheel and the radius bar connected to the cross casting at the front of the firebox, is clearly shown in the illustration.

The boiler is an exact duplicate of the one used on the previous engines, as are also the wheels and other important details.

All of these additions have increased the weight of the engine, making it nearly 12,000 lbs. heavier than the previous design. This, as above mentioned, makes them the heaviest passenger locomotives in the world. In the following table are given six of the recent heavy passenger locomotives of the Prairie and Pacific types, with the principal ratios of each, by which comparison can be made with this large machine.

	L.S.&M.S. 2-6-2	P. R. R. 2-6-2	Erie. 4-6-2	B. & O. 4-6-2	A.T.&S.F. 4-6-2	N. Y. C. 4-6-2
Total weight, lbs.	244,700	234,500	230,500	229,500	226,700	218,000
Weight on drivers, lbs.	170,000	166,800	149,000	150,500	151,900	140,500
Size, cylinders, ins.	21½x28	21½x28	22½x26	22x28	17&28x28	22x26
Diameter, wheels, ins.	79	80	74	74	73	75
Tractive effort, lbs.	27,850	27,520	30,260	31,100	32,800	28,500
Total heating surface, sq. ft.	3,905	3,876	3,322	3,417.6	3,595	3,758
Tube heating surface, sq. ft.	3,678	3,677	3,119	3,234.6	3,402	3,554
Firebox heating surface, sq. ft.	227	198	202	183	193	204
Grate area, sq. ft.	55	55	56.5	56.5	54	50
Tractive effort ÷ total heating surface	7.13	7.1	9.1	9.1	9.1	7.6
Weight on drivers ÷ tractive effort	6.1	6.05	4.93	4.84	4.62	4.93
Total weight ÷ tractive effort	8.8	8.5	7.6	7.4	6.9	7.65
Tractive effort x diameter drivers ÷ heating surface	563	568	672	672	670	569
Total heating surface ÷ grate area	71	70.5	58.8	60.5	66.5	75
Firebox heating surface ÷ tube heating surface, per cent	6.17	5.5	6.5	5.68	5.67	5.75
Weight on drivers ÷ total heating surface	43.6	43	44.9	44	42.2	37.4
Total weight ÷ total heating surface	62.7	60.5	69.5	67	63	58

For details of the boiler, cylinders, frames, etc, reference can be made to the drawings published with the description of the previous engine. The general dimensions and weights of this new order, which in the railroad's classification are known as Class J42, are as follows:

SIMPLE PRAIRIE TYPE LOCOMOTIVE WITH WALSCHAERT VALVE GEAR—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Bit. coal.
Tractive power	27,850 lbs.
Weight in working order	244,700 lbs.
Weight on drivers	170,000 lbs.
Weight of engine and tender in working order	403,700 lbs.
Wheel base, driving	14 ft.
Wheel base, total	34 ft. 3 ins.
Wheel base, engine and tender	62 ft. 5½ ins.

CYLINDER.

Kind	Simple.
Diameter and stroke	21½ x 28

VALVES.

Kind	Piston
Diameter	12 ins.
Greatest travel	6 1-16 ins.
Outside lap	1¼ in.
Inside clearance	⅛ in.
Lead in full gear	7-32 in.

WHEELS.

Driving, diameter over tires	79 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	10 x 12 ins.
Driving journals, others, diameter and length	10 x 12 ins.
Engine truck wheels, diameter	42½ ins.
Engine truck, journals	6½ x 12 ins.
Trailing truck wheels, diameter	48 ins.
Trailing truck, journals	8 x 14 ins.

BOILER.

Style	E. W. T.
Working pressure	200 lbs.
Outside diameter of first ring	70 ins.
Firebox, length and width	108 x 73 ins.
Firebox plates, thickness	⅜ & ½ in.
Firebox, water space	4 & 4½ ins.
Tubes, number and outside diameter	322-2¼ in.
Tubes, length	19 ft. 6 ins.
Heating surface, tubes	3,678 sq. ft.
Heating surface, firebox	227 sq. ft.
Heating surface, total	3,905 sq. ft.
Grate area	55 sq. ft.
Smokestack, diameter	18 & 21¾ ins.
Smokestack, height above rail	14 ft. 10½ ins.

TENDER.

Tank	Water-bottom
Frame	13 in. channel.
Weight	159,000 lbs.
Wheels, diameter	36 ins.
Journals, diameter and length	5½ x 10 ins.
Water capacity	7,000 gals.
Coal capacity	15 tons.

TRAINING OF LABORERS.—In investigations conducted by Mr. Frederick W. Taylor it was found that most laborers waste considerable of their effort by false moves. For example, in unloading pig iron from a car, which work requires the lifting of pigs weighing, say, about 90 lbs., carrying them to the edge of the car and throwing them overboard, there was found to be a lack of continuous effort. The laborer would stoop down, pick up the pig, stand for a moment and then start for the side of the car. It was suggested that the movements should be co-ordinated so that the impulse required to pick up the pig should be continued until it was dropped over the side of the car. The surprising result was found that where an ordinary laborer had been able to handle only about twelve tons per day, under the new system he handled about forty-eight tons per day. Again, in the matter of shovelling coal, the shape of the shovel and its size were found to be very important factors, and by studying the problem the amount of coal that could be handled by the average laborer with no greater tiring than before was greatly increased. From this experience it is quite evident that the training of laborers may be quite as important as the training for the so-called trades. The training of the laborer, of course, will be more that of muscle training than of brain training, but it is nevertheless quite as important in the cost of production where large quantities of materials must be handled by manual labor.—*Machinery.*

PROPOSED AMERICAN RAILWAY CONGRESS.—Mr. L. C. Fritch, assistant to the general manager of the Illinois Central Railroad and formerly secretary of the American Railway Engineering and Maintenance of Way Association, has developed a plan for the union of the American Railway Association, Master Car Builders' Association, American Railway Master Mechanics' Association and the American Railway Engineering and Maintenance of Way Association into one representative body. It is claimed that such an organization could do better and more effective work than is possible with the four separate organizations. The proposed congress would be divided in three sections: transportation, maintenance of way and maintenance of equipment.

LIMITATION OF BIG LOCOMOTIVES.—There has been a good deal said and written lately about the inability of the big engine to haul its theoretical rating. There are several reasons for this failure to get the most out of the big engine, the principal one of which perhaps is the inability of the fireman to maintain steam, or, in other words, the hauling capacity of the big engine is, to a considerable extent, measured by the firing capacity of the fireman.—*D. Van Alstyne, before the Western Railway Club.*

LOCOMOTIVE PERFORMANCE SHEETS.

By H. H. Vaughan.

The immediate intention of a performance sheet is familiar to all mechanical and operating officers. Following the information obtained as to the expenditures on a road or a division for repairs, fuel, oil and waste comes the desire to compare the expenses of individual engines in order to ascertain whether one is more extravagant or economical than another, in one or all of these items, or to watch the results obtained on any engine from month to month. Beyond this reason there is another which is of greater importance—the presentation to the men operating and maintaining the engines of the work they are performing in a sufficiently clear and apparent manner to incite them to improvement or to call attention to wasteful handling, or to engines that are defective or unnecessarily expensive.

While the object to be attained by a performance sheet is evidently desirable, and few will question the possibilities of saving in expenses which would result from its realization, it is doubtful whether such sheets, as frequently arranged and issued, are really of vital interest to the men in general. In the first place, since they include the cost of repairs each month, they cannot be issued on most roads until the monthly accounts are closed, and as accounting offices are frequently busy at that time in furnishing general statements for executive officers, which are wanted as quickly as possible, the performance sheets are allowed to take their place and issue from four to five weeks after the end of the month they refer to. In the second place, their arrangement while sufficient to present the information they contain, is not designed to indicate without considerable study which engines attain the better and which the worse results; neither do they in general furnish sufficient information to enable their user to draw his conclusions without obtaining further details.

While there is a considerable variation on different roads, what may be termed a general type of performance sheet would show on one page information for each engine, under columns headed about as follows:

Engine number.	Miles, total.
Class.	Tons hauled one mile.
Type.	Coal, tons.
Working between.	Engine oil, pints.
Engineers.	Valve oil, pints.
Miles, train.	Illuminating oil, pints.
Miles, light.	Waste, pounds.
Miles, doubling or assisting.	Cost of repairs.
Miles, switching.	

Amount or cost of these items used per locomotive mile and per 1,000-ton mile.

The above sheet would be issued separately for passenger, freight and work service, in which case an engine might appear on two sheets or combined when the mileage in the different services may be subdivided in the mileage columns, but it is not then usual to subdivide the coal used.

While this type of sheet is termed general, no statement is intended that it is universal, although a somewhat similar arrangement was extensively in use some years past. While containing valuable information, it is, however, open to the objections previously recited, and as an attempt has been made on the Canadian Pacific to compile the figures in a manner that will appeal more definitely to the men concerned, the sheets in use on that road will be described to illustrate what is considered a preferable arrangement.

The general performance sheet actually contains information about three items—coal, oil and repairs—and, as previously stated, the repairs are the chief cause of the delay in the issuance of the figures. Coal figures, to be of value, must be promptly published, as it is impossible for men to account for an excessive consumption that occurred some weeks previously, and the same remarks apply to those for oil. Repairs, coal and oil also require the engines to be differently grouped for convenient comparison. For these reasons the sheet has been subdivided into three to show the performances for coal, oil and repairs separately.

The coal sheet is issued bi-monthly in place of monthly, as this has been found preferable. When first introduced it was made up weekly, but the objections developed that the work done by the engines was hardly sufficient to arrive at satisfactory average figures, and the work of looking into the reasons for poor results, or, indeed, of going over the sheets thoroughly, was too great. In order to obtain the figures promptly an accounting force was installed at each division headquarters, and the coal records are now in the hands of the motive power department within a week or ten days of the close of the period they cover. An example of the coal performance sheet is shown above.

It will be seen that each run between terminals is shown separately, and freight, way freight and passenger results are also separated. Each group of engines is totalled, and those in each group are divided to show which are better and which worse than the average of the group. The column headed "average load per mile" has been introduced to allow for the variation in loads in direction contrary to traffic or fast running, as were the results subdivided into east and west bound, it would necessitate an accurate measure of the coal on the tender, which is under this plan less important, although

CANADIAN PACIFIC RAILWAY COMPANY

Performance of Locomotives, Lake Superior Division, Period Ending April 20, 1906.

Running between Chalk River and North Bay, Distance between Terminals 118 Miles.

Class of Service	Loco. No.	Haulage Capacity Per Cent.	Local Miles. Train.	Light.	Doubling or Assisting.	Switching.	Total.	Gross Tons Hauled One Mile.	Coal Consumed Tons.	Coal Consumed Per Unit Mile. Average Load Per Mile.	Better than Average.	Worse than Average.
Freight	67	60	13	13	....	....	26	5,221	¾	....	....	....
	630	100	472	5	5	....	482	276,611	31¾	574	230	....
	740	155	1,278	24	4	....	1,306	1,124,478	81	861	144	....
	741	155	236	....	....	....	236	188,823	12¾	800	135	....
	757	155	702	....	....	6	708	658,229	43½	930	132	....
	760	155	1,298	121	3	27	1,449	1,171,484	83½	808	143	....
	761	155	1,180	7	7	....	1,194	1,077,335	75¾	902	141	....
	762	155	590	121	3	....	714	488,641	36¾	684	....	150
	763	155	944	19	20	....	983	844,520	69¼	859	....	164
	764	155	236	....	....	....	236	176,840	14¾	749	....	167
			6,464	292	37	33	6,826	5,730,350	417¼	839	146	....

Note.—"Gross Tons Hauled One Mile."—Actual for Passenger; Equivalent for Freight and Mixed; including allowance for Road Switching at rate of 200 tons per mile for Passenger and Mixed, and 300 tons per mile for Freight Trains.
"Coal Consumed per Unit Mile."—"Unit Mile" represents 1,000 tons hauled one mile.

even now an engine working both ways out of a terminal occasionally shows bad results in one direction and good in the opposite.

The oil and waste performance sheet is shown below.

This sheet is issued monthly for each division, and the

CANADIAN PACIFIC RAILWAY COMPANY

ONTARIO DIVISION

Oil and Waste Performance of Locomotives, February, 1906.

Loco. No.	Type.	Mileage.	ENGINE OIL. Allowance Pints.	ENGINE OIL. Issued Pints.	ENGINE OIL. Excess Pints.	ENGINE OIL. Credit Pints.	ENGINE OIL. Excess or Credit Per Cent.	VALVE OIL. Allowance Pints.	VALVE OIL. Issued Pints.	VALVE OIL. Excess Pints.	VALVE OIL. Credit Pints.	VALVE OIL. Excess or Credit Per Cent.	HEADLIGHT OIL. Issued Pints.	HEADLIGHT OIL. Miles Run to One Pint.	SIGNAL OIL. Issued Pints.	SIGNAL OIL. Miles Run to One Pint.	WASTE. Issued Pounds.	WASTE. Miles Run to One Pound.	Other Supplies Value.
TLE :P3	8 W	3,710	92¾	66½	....	26¼	28	26½	33	6½	....	24	30	124	8	464	10½	353	....
C. P. 95	"	3,749	93¾	83	....	10¾	11	26¾	28	1¼	....	5	48	78	12	312	3	1,250	3.44
145	"	1,858	46½	68	21½	....	46	13¼	20½	7¼	....	55	56	33	8	232	8	232	.06
186	"	380	9½	10¼	¾	....	8	2¾	4	1¼	....	45	26	15	2	190	¾	507	12.55
188	"	3,230	80¾	96	15¼	....	19	23½	25	1½	....	6	80	40	7	461	11	294	1.18
203	10 W	4,441	148	160½	12½	....	8	44½	52	7½	....	17	20	222	7	634	5¾	772	3.12
205	"	4,370	145½	152	6½	....	4	43¾	50½	6¾	....	15	16	273	8	546	5	874	.43
220	"	4,254	141¾	144	2¼	....	2	42½	45	2½	....	6	28	152	9	473	5	85	4.30
257	8 W	3,456	86½	72	....	14½	17	24¾	24	....	¾	3	24	144	6	576	18	192	

engines are simply arranged in numerical order. The figures for headlight, signal oil and waste are shown in the usual way by the number of miles run per pint or pound, but those for engine and valve oil are calculated rather differently. It is the custom for each engine to be allowed a certain number of miles per pint, according to its class. Should an engine thus run on its allowance, it has evidently equalled the number of miles per pint called for on the schedule for its class, and by showing on this form the amount and percentage by which each engine has exceeded or run within its allow-

CANADIAN PACIFIC RAILWAY COMPANY

MONTHLY STATEMENT OF COST OF RUNNING REPAIRS

Atlantic Division. Contd. — Month Ending February, 1906.

Engine No.	Headquarter Station.	Last Repair No.	Last Repair Mileage.	Month of February: Rate.	Cost B. W.	Cost O. W.	Cost Defect.	Cost Total.	Mileage	Per Mile.	Excess.	Decrease	Total to Date: Mileage from No. 1.	Cost B. W.	Cost O. W.	Cost Total.	Per Mile.	Excess.	Decrease
541	Woodstock	....	....	2.0	.34	128.15	....	128.49	2,745	4.69	73.69	....	32,854	....	....	903.17	2.75	249.09	....
542	Woodstock	....	....	2.0	....	33.39	....	33.39	4,045	.83	....	47.51	35,161	66.41	635.66	702.07	2.0	....	1.15
613	McAdam	2	955	2.0	7.42	35.42	....	42.84	2,212	1.93	....	1.40	47,285	27.13	612.99	640.12	1.35	....	304.58
616	Brownville	....	....	2.0	7.72	77.09	....	84.81	3,723	2.28	10.35	....	48,499	23.64	695.74	719.38	1.48	....	250.60
634	Bay Shore	....	....	2.0	....	32.33	....	32.33	2,766	1.17	....	22.99	644	....	25.83	25.83	4.0	12.95	....
D 1-3	....	....	....	....	15.48	306.38	....	321.86	15,491	2.08	12.04	....	....	....	....	....	....	....	....
930	Brownville	....	....	2.7	....	4.15	....	4.15	123	3.37	.83	....	45,322	56.32	1,069.80	1,126.12	2.49	....	94.12
933	Brownville	....	....	2.7	.30	149.50	....	149.80	4,823	3.11	19.58	....	34,657	34.71	800.96	835.67	2.41	....	100.06
945	Brownville	....	....	2.7	9.33	137.96	....	147.29	4,137	3.57	35.60	....	26,855	43.15	754.47	797.62	2.97	72.54	....
970	McAdam	....	....	2.7	.67	90.57	....	91.24	4,652	1.96	....	34.36	24,233	25.19	353.52	378.71	1.56	....	275.57
985	McAdam	2	22,638	2.7	3.61	91.70	....	95.31	4,607	2.07	....	29.08	49,885	....	....	1,604.73	3.21	258.86	....
992	McAdam	2	22,544	2.7	5.69	118.55	....	124.24	4,543	2.74	1.58	....	46,694	52.70	1,250.65	1,303.35	2.8	42.63	....
D 6	....	....	....	....	19.60	592.43	....	612.03	22,885	2.68	....	5.85	....	....	....	....	....	....	....

ance, those using the greater are clearly divided from those using a lesser amount per mile, whereas when these figures are shown by miles per pint, it is necessary in criticising them

to know how much each engine should properly consume in order to so separate them. A column is also introduced on this sheet to show the value of the "other supplies" charged to each engine, which enables a watch to be kept on this item without complicating the coal and repair statements.

The repair statement, shown on opposite page, includes only running repairs, which on this road are defined as those costing under $100 for labor. Shop repairs are analyzed entirely separately and without reference to the monthly mileage, so that they don't come within the scope of a performance sheet. This form requires some explanation. It is made up by divisions, and on each division the engines are arranged by groups of one or more classes. The headquarter station is the point out of which the engines were running during the month, as all engines are assigned to some terminal, the other end of the run being considered a turn-around point as far as possible. The column "last repair" shows the class of machinery repairs last received, and the mileage made at that time since last general overhauling of machinery. If not filled in, the engine has received no shop repairs since its last general or No. 1 machinery. The rate is an arbitrary figure, based upon the tractive force which is partially intended to set a cost at which the engines should be maintained, but more to divide them into those which are above and below it. On the Northern Pacific, where a very similar sheet is employed, of which this is a modification, the rate is determined from the actual cost over several previous years, which has the advantage of demonstrating that the engines could be maintained at the rate set. On the Canadian Pacific, in view of the importance of the tractive power mile, that being the figure on which the general maintenance account is criticised, it is preferable to base the rate or allowance on the same unit, as it can then be determined which groups or divisions have increased or decreased the general cost. The factor on which the rate is based is really not important, provided the results are not all above or all below it, and the one shown, which is based on one cent per 1,000-lb. tractive power mile, is satisfactory in that respect. The Columns "B. W." and "O. W." show respectively the cost for boiler work and other work, a separation that is important in making comparisons between divisions on which the quality of water varies, and that headed "defect" is to record the cost of repairs, such as broken piston rods, crankpins, etc., for which the division is not actually responsible, but which do not come under the head of wreck damages. The columns "excess" and "decrease" show the amount by which the repairs exceed or are below the allowance based upon the rate and the mileage, and, together with that headed "cost per mile," enable the results to be taken in at a glance. The figures all apply to the results for the month, but, as is well known, one month's results even on running repairs vary to a great extent on the same class of engine and service. The general touch up given an engine when receiving a staybolt test may run that month's expenses up, but reduce the costs for the next sixty days, and it is therefore necessary not only to know what an engine has cost in one month, but how much it has cost during a considerable period before drawing any conclusions. To show this the figures under "Total to date" have been introduced. These show the mileage made, costs, etc., since the engine last received a No. 1 or general overhauling of machinery to the end of the month preceding that for which the sheet refers to. The reason for not including the last month is to enable these figures to be made out and entered on the form in advance of the receipt of the monthly reports, which reduces the time required to write out and distribute the performance sheet.

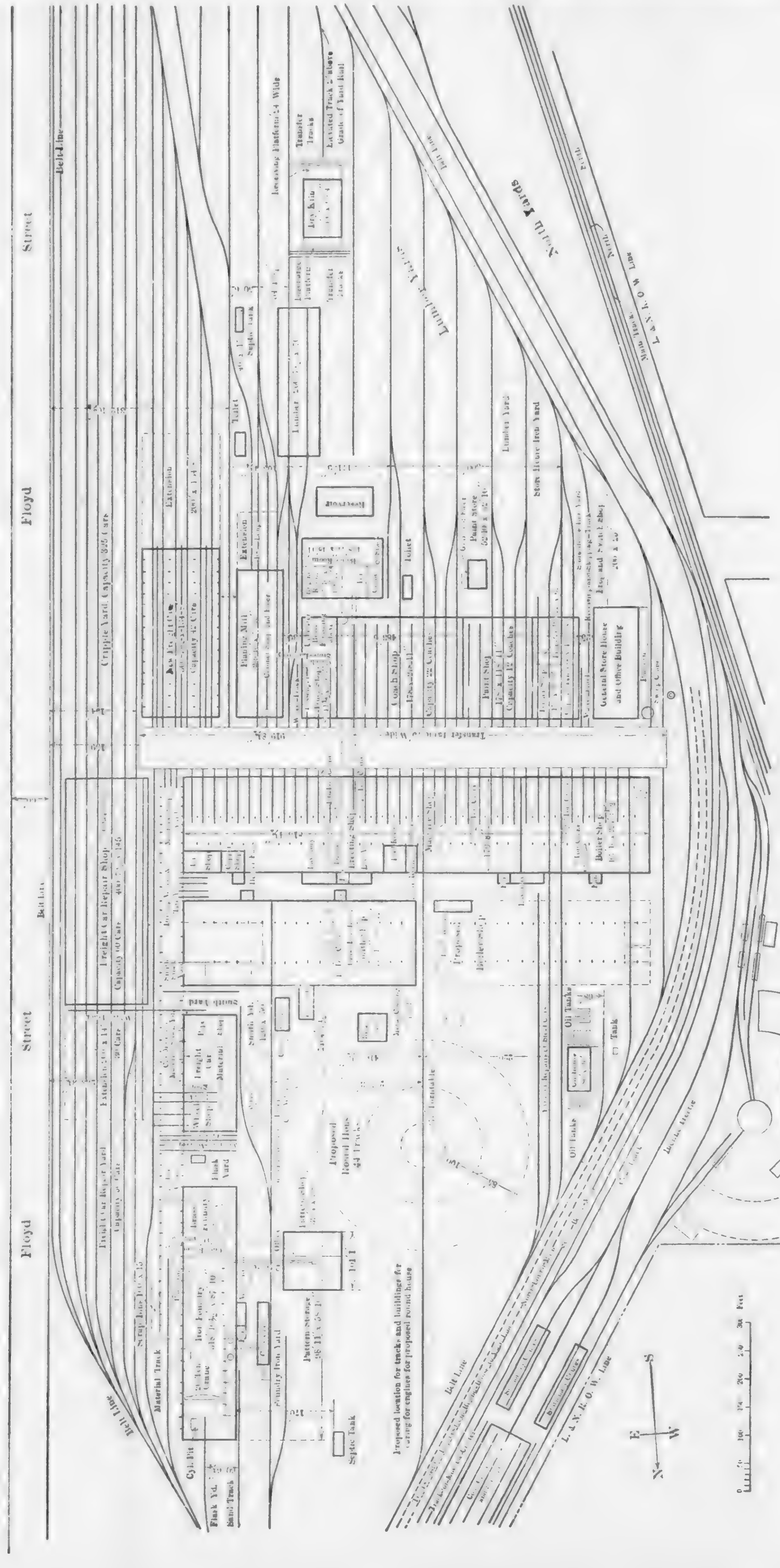
Probably none of the sheets that have been described are in their final form, but they have certain advantages over the inclusion of the various figures on a general performance sheet that are certainly strong arguments for a somewhat similar arrangement. They are obviously and, in fact, are entirely designed to meet the requirements of a service where men are regularly assigned to their engines, and would need modification were pooling in use. Certain features have, however, proved distinctly advantageous. The separation of the results above and below the average figure in the case of coal, and a rate or allowance for oil and repairs, has the result not only of enabling the good and poor performances to be detected at a glance, but exhibiting them in a way that appeals to the engine crews and all others concerned, and this has undoubtedly led to increased interest and improved results.

The separation of the coal, oil and repair sheets has made it possible to obtain the coal sheet, which is the one most promptly needed, within a sufficiently short time to make every one feel that the figures relate to recent and not historical events, and to call attention to an engine whose condition was such as to lead to increased consumption before the defect became serious enough to interfere with the handling of a train. The use of separate sheets has enabled the coal reports to be classified by runs, service and groups of engines, the repair reports by groups and headquarter statistics, while any report could be classified in any way thought desirable without affecting that method required for another, something that is quite important if comparisons are to be easy and effective as well as odious.

At first sight the clerical labor involved might appear formidable, but this is more apparent than real. The figures on the coal and oil sheets must all be obtained, and it is only those for the excess and decrease that are additional. The change consists more in the rearrangement than the number of the items except in the repair sheet, where the "Total to date" is an addition to the figures usually furnished. At the outside not over two men's time additional is required, compared to those for preparing a set of single performance sheets for 500 engines, and as the expenditures detailed would amount to $100,000 to $300,000 per month, it is evident that a saving of one-tenth of one per cent. would cover the additional cost. This is not material when the magnitude of the expenditures is considered, and in view of the fact that the performance sheets are practically our only detailed statements of the disbursement of coal, oil and running repairs, the writer believes that their form is worthy of careful study in order to render them as explicit and convincing as possible, and appeal to the individual to whom it is necessary finally to look for improvement and economy.

CONCRETE RAILROAD TIE.—In the April issue of the *Cement Age*, Mr. G. H. Kimball, chief engineer of the Chicago & Alton Railway, describes a concrete tie, several of which have been in service over four years with satisfactory results. The tie consists of two blocks of concrete each 3 ft. long, placed symmetrically under each rail so that the center of pressure and the center of figure of each section of the tie will coincide. These two blocks of concrete make one tie and are rigidly connected by being molded on the ends of a pair of 3-in. channels weighing three pounds per foot. The channels are back to back and spaced 2 ins. apart in the clear. The concrete blocks are 7 ins. thick and 9 ins. face, and the cross section is the same as that of a timber tie hewn or slabbed from a log about 11 ins. in diameter. It presents the appearance in the track of an ordinary tie with a piece 2 ft. 11ins. long cut out of the center. Hardwood blocks 3 ins. thick, 9 ins. wide and 18 ins. long, designed to cushion shocks, distribute pressure, support derailed trucks and serve as spiking blocks, are secured to the top of the concrete blocks. Each hardwood block is, of course, centered transversely to the line of the rail. Cast iron sockets that also serve to space and connect the channels are molded in place in the concrete, serve as an anchorage for holding down the hardwood blocks. These sockets receive suitable bolts, head down, so that when they are slipped to place and the holes through which they are introduced have been plugged they cannot be withdrawn. It is estmated that the ties weigh 436 lbs. apiece, and will cost about $1.18 each.

The saving of a few dollars in salary is often very expensive.



GENERAL PLAN OF SOUTH LOUISVILLE LOCOMOTIVE AND CAR SHOPS.—LOUISVILLE & NASHVILLE RAILROAD.

SOUTH LOUISVILLE SHOPS.

LOUISVILLE & NASHVILLE RAILROAD.

I.

GENERAL PLAN AND OPERATION.

The feature that impresses one most forcibly in studying the Louisville & Nashville Railroad shops at South Louisville is the careful provision for having the raw materials, which enter at the two ends of the plant (wood at one end and metal at the other), travel steadily toward their objective point, near the centre of the plant, which they reach in a finished state, requiring a minimum amount of handling and without doubling on their tracks. Not only does this idea predominate in the general arrangement of the shops, but, also as concerns the equipment and arrangement of each one of the shops. As the greater part of the manufacturing work for the entire system is done at this point and as considerable new equipment is built, in addition to the repair work, it is, of course, possible to develop this idea to a greater extent than if the shops were used entirely for repair work, although this arrangement could also be used to considerable advantage under such conditions.

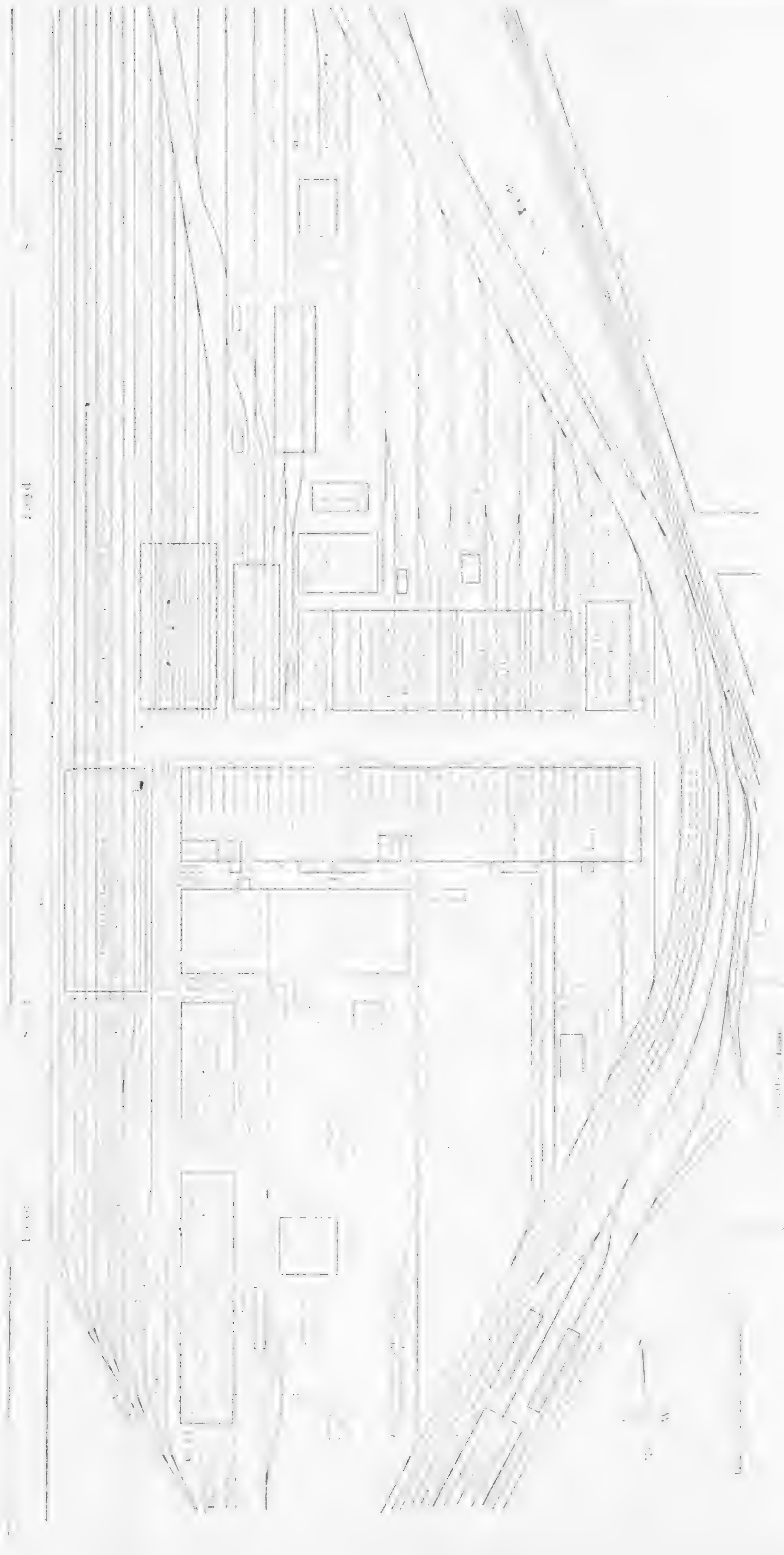
As may be seen by referring to the general plan, the shops are arranged about an L-shaped system of transportation, consisting of a high speed transfer table, which travels over a distance of about 920 ft., or nearly the full width of the plant and an overhead high speed 10-ton travelling crane, extending over the stock yard for raw and semi-finished material, which is 1,000 ft. long and 40 ft. wide. Both the crane and the transfer table operate at a maximum speed of 1,000 ft. per minute. The metal working departments, including the machine and erecting shops, smith shop, wheel and axle shop and foundry, extend alongside of the travelling crane and the transfer table lies between the locomotive shop on one side and the freight car shop, planing mill, coach and tender shop and storehouse on the other.

At first sight the use of the transfer table in connection with the locomotive shop may be criticized. Ordinarily the engines are brought into the shop over this table. They can however, if necessary, be brought in from the north end of the plant over the track which enters near the middle of the locomotive shop, and by means of the 100-ton crane can be placed on any pit in the erecting shop. This department can, therefore, if necessary, get along without using the transfer table at all and not interfere greatly with its efficiency. It has been found that under normal conditions the transfer table is used 95 per cent. of the time by the car department and only 5 per cent. of the time by the locomotive department. As it seems to be practically impossible to handle coach work to advantage without the use of a transfer table, and as it is not in this instance necessary to the working of the locomotive department, but incidentally is a considerable convenience in handling the work of that department, the arrangement is to be commended. The transfer table could be put out of commission for several days without greatly interfering with the progress of the work through either the car or locomotive shops. The belt line around the plant and the arrangement of the tracks is such that the only points which would not be accessible would be a couple of tracks in the coach shop. Some difficulty would be experienced in delivering material from the planing mill to the freight car and coach shops, and in getting the passenger car trucks out of or into the coach shop, or in the quick delivery of material from the general storehouse to the various shops, although these difficulties would be overcome to a very great extent by the use of a large force of laborers. In one year's service the transfer table has not been disabled more than five hours. The use of the transfer table, and the fact, that switching may be done from either side of the plant, obviates the use of narrow gauge tracks and turntables. A feature which contributes to the safety of the men and facilitates the switching movements is that the tracks inside the plant are straight and the curves are largely confined to the belt line at the outer edge of the plant.

TRANSFER TABLE—LOCOMOTIVE SHOP AT THE LEFT.

A general study of the course of the various materials from the raw state to the finished product may make the advantages of the layout more apparent. In general the heavy metal parts are lifted and transported overhead, while the timber is transported on low cars with as little lifting as possible. All metal enters at the north end of the plant; part of it is unloaded at the foundry platform and transferred by the travelling crane to its proper place in the stock yard or to the various shops. The raw material for the foundries is delivered and stored at the west side of the building. The finished castings are taken out at the east side and are loaded from the platform directly on the cars, if they are intended for shipment to outside points, or if for storage or use in the plant are delivered to the proper place by the travelling crane and the transfer table. The wheels and axles are stored west of the wheel and truck shop. Stock from the blacksmith shop and foundries for use in the truck shop is stored underneath the travelling crane. The trucks, after they are set up, are transferred to the freight car shop by means of the travelling crane and transfer table. The double trolley on the travelling crane permits two freight car trucks to be handled at one time as well as conveying double loads of various kinds of material. Raw material for use in the smith shop is stored in the yard at the north side of the building. In some instances the cars are unloaded directly in the shop. Material manufactured in this shop for shipment to outside points is usually loaded on cars in the shop. Material for use in other parts of the plant is delivered by the cranes to the stock yard crane. Boiler plate, flues, bar steel, etc., are stored to the north of the boiler shop building. The division between the boiler and the machine and erecting shop consists of a low brick wall over which material can readily be transferred by the travelling cranes. Nine-tenths of the metal which passes beyond the transfer table on the car side is used in the freight car shop, which is just across the transfer table from the end of the stock yard crane. Locomotives coming into the shop are taken on the transfer table at the west end. The tenders are either taken into the tender shop or are stored on tracks at the rear of this shop.

Lumber enters the plant at the south end. The sills are stored to the east of the dry kiln. The lumber yard south



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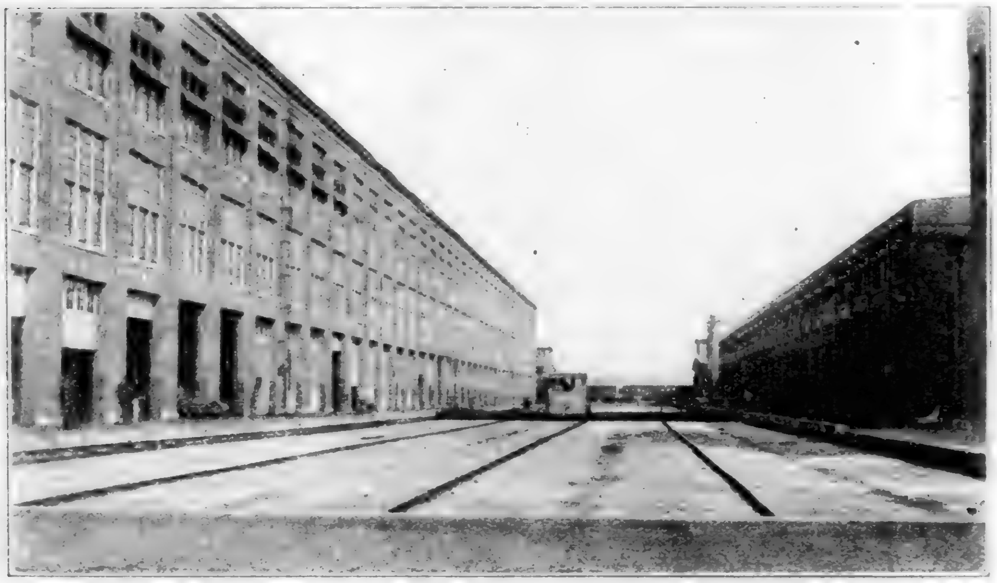

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of the coach shop has a capacity for ten million feet of lumber. The lumber is transported on cars 2 ft. high. That which goes through the dry kiln is loaded on special cars and these cars after passing through the kiln are run onto the yard cars and transported to the lumber shed or to the planing mill and cabinet shop, as may be desired. All timber enters the planing mill at the south end and is delivered at the north end in a finished state and is transferred to either the freight car shops or to the coach shop by the transfer table. The coaches and tenders are brought into the shop over the transfer table but in case of an emergency can be brought in over the tracks at the south side of these shops. Freight cars needing repairs are stored in the cripple yard of 325 cars capacity. They are repaired either in the freight car repair shop, which has a capacity for 60 cars, or in the repair yard, which has a capacity for about 80 cars. The freight car repair shop is so located that finished material for use on the cars is carried, on an average, only 60 ft.

TRAVELLING CRANE AND STORAGE YARDS—VIEW FROM ABOVE.

The shops have been in operation for considerably less than a year, and at the present time repair about 30 engines and build two new ones each month. The car department repairs about 100 freight cars and builds about 15 new 80,000-lb. capacity gondola cars per day. In the coach shop about 30 coaches are repaired and about two new ones built each month. The shops are so arranged that by the extension of the buildings and rearrangement of the departments their capacity can be increased about one-third. The dotted lines on the plan show the extensions which may readily be made to the various buildings. If a new boiler shop should be required it can be located as shown, and the space occupied by the present one can be added to the erecting and machine shops. Provision is also made for the erection of a 44-stall roundhouse, as shown.

The power house is located near the planing mill in order to use the shavings for fuel. As the amount of power required by the planing mill is comparatively large the centre of gravity of the power distribution would probably lie somewhere near the center of the transfer table and the power plant is thus not as far from the center of distribution as might appear.

The general storehouse for the entire Louisville & Nashville System is located near the west end of the transfer table. This storehouse receives and delivers all store supplies to and from the shop, by the use of the transfer table and small cars. It is also located to permit of easy switching from the belt line to either side of the storehouse. This enables the store department to receive all shipments of material from the outside in carload lots and redistribute it in like manner. A large oil station is provided, directly west of the blacksmith shop. It has capacity for sixty days' supply of oil for the Louisville & Nashville System, north of Nashville. A supply of 30,000 gals. of crude oil is provided, as this fuel is used largely in the smith shop and brass foundry.

The plant occupies a tract of 55 acres, 12½ of which are under roof. The buildings are arranged and designed to secure north light and avoid direct sunlight in the buildings, this being an important consideration in the latitude of Kentucky. They are also arranged to take advantage of the southern breezes, an important feature during the summer months. The plant was laid out and the equipment selected and arranged by Mr. Theodore Curtis, superintendent of machinery. The buildings were designed and their construction supervised by the engineering department of which Mr. W. H. Courtenay is chief engineer, under the direct charge of Mr. J. Werness, principal assistant engineer.

TRAVELLING CRANE AND STORAGE YARD.

(To be continued.)

FREIGHT CAR CONSTRUCTION AND ITS COMMERCIAL ASPECT.

By L. H. TURNER.

To the man who has been more or less closely allied with car construction and maintenance for over a third of a century the subject presents many interesting and oftentimes amusing features. The car builder of thirty-five years ago made but little use of the technical assistant, and, in fact, but few technical men were employed in the work. Testing machines and laboratories were scarcely known, and the trained eye of the mechanic was the gauge of strength and utility. The commercial side of the question did not receive the consideration it does to-day when the greatest effort is made to obtain the lowest possible light weight with the maximum carrying capacity. The introduction of malleable castings and pressed steel shapes in modern cars has worked wonders in adding to the earning capacity and reducing the total weight of train load, and while a wonderful improvement has been made in the general construction of freight car equipment, we have been inexcusably blind to some points that should have been seen years ago.

The modern steel car, the highest type of freight-carrying vehicle, has been built and probably will continue to be by some, equipped with the M. C. B. twin spring draft gear with a capacity of 38,000 lbs., and then placed behind locomotives with a tractive power ranging from 40,000 to 50,000 lbs. This is one of the results of not giving consideration to what the car is to be subjected to after it leaves the hands of the builder, or of leaving the design to some one not familiar with service conditions, either of which is disastrous to the car owner.

We overlooked another matter when we specified the twin spring gear, viz.: that steel center sills do not have the shock-absorbing capacity of the old wooden car, and that when the weight of the impact exceeds 38,000 lbs. something must take care of the balance. The coupler usually provides the means. If the coupler is strong and the sills somewhat light, then the sills bulge and a few similar jolts put the cars on the shop track.

It is no exaggeration to say that the weak point of the all-steel car or the steel underframe car is the center sills, or what might be more nearly correct, that the designer's weak point was his failure to recognize the fact that while the steel sills were amply strong to stand all pulling tests, they lacked the elasticity to stand the strain placed upon them while being handled in gravity yards or under other conditions where the treatment is beyond what is ordinarily expected of a car.

This liability to damage can and should be corrected by the application of friction draft gears and buffer blocks. We believe that the M. C. B. Association erred in not fostering and encouraging the use of buffer blocks either in the solid casting or the spring design, which is far more preferable, as they not only distribute the shock over more of the end of the car, but about double the spring capacity. Friction gears are a necessity and are productive of a great saving, and when used in connection with a spring buffer on steel cars will save and earn more than any other device that can be purchased for the same amount of money.

This fact was quite clearly shown by some observations recently taken in which one lot of steel cars equipped with one pattern of friction draft gear showed a coupler breakage of 18.5 per cent. of all on the cars so equipped. Another friction gear showed 6.9 per cent., while a mixture of wood and steel cars with twin spring attachments and in some cases spring buffers had a percentage of 4.7 per cent. It should be stated that the spring buffers were all on steel cars, indicating that buffer springs and wood are very good mediums for absorbing shocks.

While it must be conceded that the friction gears are of much help, they still do not give the same assistance as is rendered by the wooden car in absorbing the shock, and this seems to prove that something more is needed, and we know of nothing better than the spring buffer.

We have also been blind, generally speaking, to the importance of a proper center plate and side bearing. We seem to have forgotten that the same company that purchases the car has to pay the cost of hauling it, and we have built up a largely increased percentage of train resistance due to center plates of improper design, truck and body bolsters so weak as to place the greatest part of the load upon the side bearings, which of necessity must bind the truck upon the track, resulting in increased train resistance, worn flanges, worn rails, increased expenses and decreased earnings, all of which might be largely eliminated by the use of some of the devices upon the market which will to a great degree remove the friction between the car body and truck, and while it is deplorable to have to admit it, it must be confessed, meritorious appliances are often turned down because they are not the product of our own brain or at the direction of some officer who is always haunted by the phantom of "First Cost." The head of the car department of to-day must roam outside of department lines and be as zealous in considering the ultimate results and the wisdom in adding to the first cost of the car in order that he may reduce the cost of maintenance and get more miles per year out of it, due to the lesser number of trips it makes to the repair tracks, as he is in following time-honored traditions and gratifying his personal hobbies.

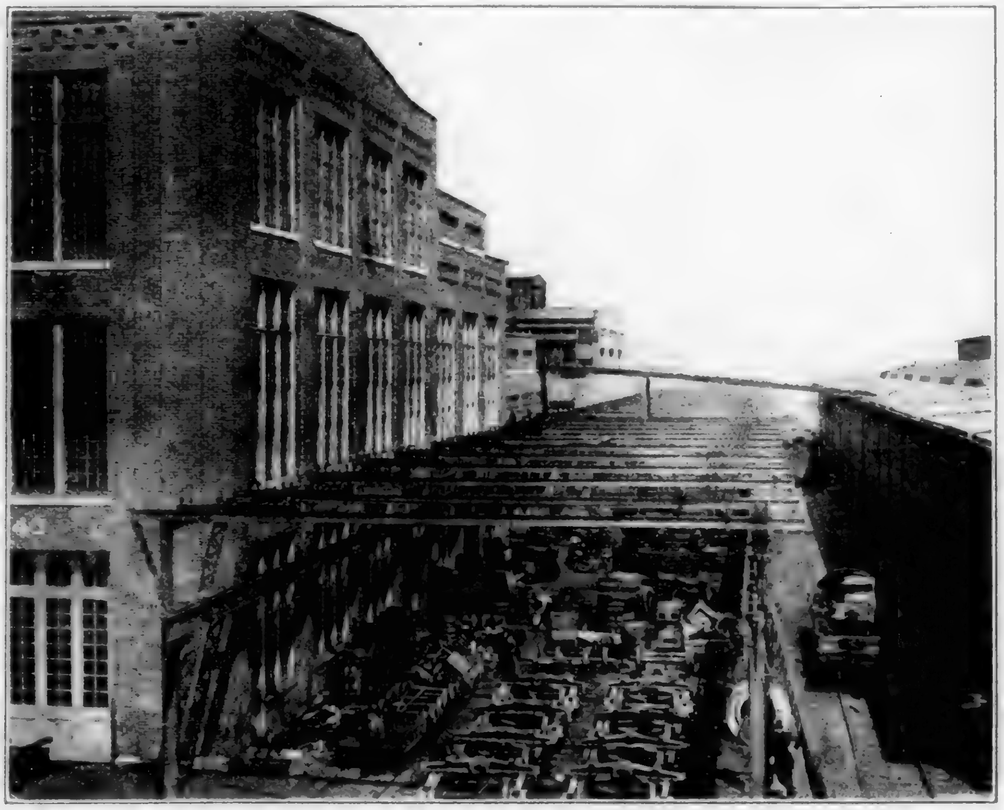
The office of the head of the mechanical department in this progressive age presents as many opportunities for working out great economies as any other employed in railroad operation, and fortunate is the road who has a mechanical head who can look above the mechanical details and recognize the fact that the car represents the earning power of the company, and is not simply a vehicle capable of sustaining a given load. The most necessary adjunct to the clear-headed mechanical man is the superior officer or purchasing power who has confidence in his ability and honesty to decide as to what type of construction will in the end prove to be the most economical and bring about the best results to the stockholders.

It is gratifying to observe that the policy of buying cars on a question of price alone, regardless of whether it would require six or ten pounds of power per ton to move them or whether they would be serviceable for five or fifteen years, is being relegated with many others that have proven to be unwise.

In confirmation of the wisdom of giving the closest attention to car construction in the way of using the lightest materials of the greatest strength in order that the revenue load may be increased to the highest per cent. of the total weight of the train, also that all pains be taken to reduce the rolling friction to the least possible draft upon the locomotive, a few figures may well be presented showing the comparative earning value of the modern steel car of 100,000 lbs. capacity costing $1,200 and the up-to-date locomotive of 40,000 lbs. tractive power costing $16,000. The car loaded to its capacity with the usual 10 per cent. excess at $0.006 per ton mile, earns $33 for each 100-mile haul. The locomotive with the liberal allowance of 500 tons of revenue freight per train earns $300 for the same distance. The cost of the car is but 7.5 per cent. of that of the locomotive, and while the cost of maintenance of the car is less than one cent per car mile, the locomotive requires at least six cents per engine mile. Placing the life of both at fifteen years, you will have expended on the locomotive for first cost and maintenance (assuming it runs 100 miles per day) $48,850, and it will have earned $1,642,500, or 3362.3 per cent. on the capitalization, while the car will have cost $2,295, and will have earned $36,135, or 1574.5 per cent. on the capital invested.

Owing to traffic and other conditions, cars only average twenty miles per day, and this might be regarded as a suggestion to the transportation departments that the most fruitful source of increased earnings is by increased mileage of freight cars. The figures given above plainly show that if by a reduction of terminal and shop track delays the car can be made to make forty miles a day, that its earnings on the

of the coach shop has a capacity for ten million feet of lumber. The lumber is transported on cars 2 ft. high. That which goes through the dry kiln is loaded on special cars and these cars after passing through the kiln are run onto the yard cars and transported to the lumber shed or to the planing mill and cabinet shop, as may be desired. All timber enters the planing mill at the south end and is delivered at the north end in a finished state and is transferred to either the freight car shops or to the coach shop by the transfer table. The coaches and tenders are brought into the shop over the transfer table but in case of an emergency can be brought in over the tracks at the south side of these shops. Freight cars needing repairs are stored in the cripple yard of 325 cars capacity. They are repaired either in the freight car repair shop, which has a capacity for 60 cars, or in the repair yard, which has a capacity for about 80 cars. The freight car repair shop is so located that finished material for use on the cars is carried, on an average, only 60 ft.



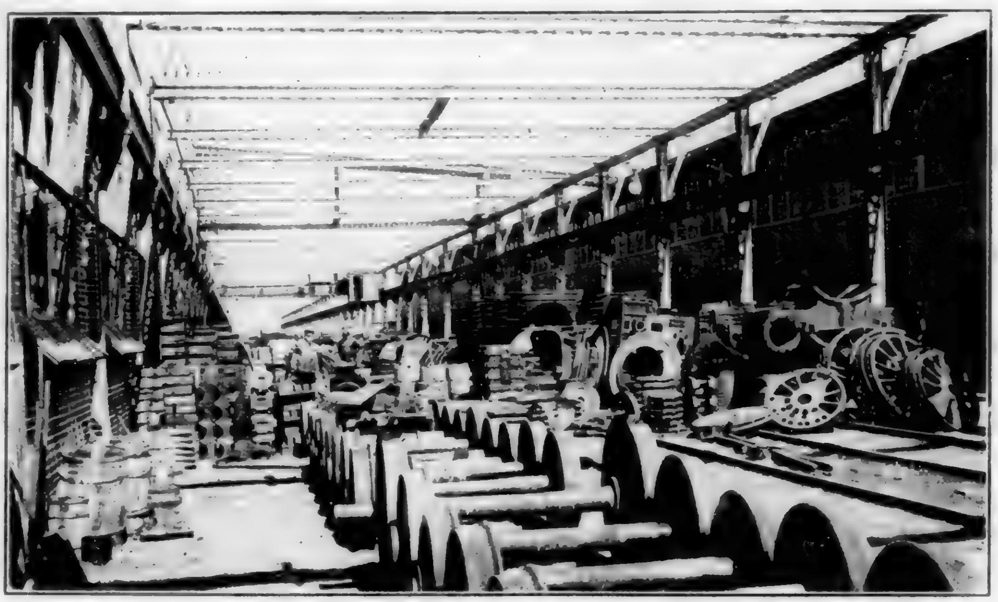
TRAVELLING CRANE AND STORAGE YARDS—VIEW FROM ABOVE.

The shops have been in operation for considerably less than a year, and at the present time repair about 30 engines and build two new ones each month. The car department repairs about 100 freight cars and builds about 15 new 80,000-lb. capacity gondola cars per day. In the coach shop about 30 coaches are repaired and about two new ones built each month. The shops are so arranged that by the extension of the buildings and rearrangement of the departments their capacity can be increased about one-third. The dotted lines on the plan show the extensions which may readily be made to the various buildings. If a new boiler shop should be required it can be located as shown, and the space occupied by the present one can be added to the erecting and machine shops. Provision is also made for the erection of a 44-stall roundhouse, as shown.

The power house is located near the planing mill in order to use the shavings for fuel. As the amount of power required by the planing mill is comparatively large the centre of gravity of the power distribution would probably lie somewhere near the center of the transfer table and the power plant is thus not as far from the center of distribution as might appear.

The general storehouse for the entire Louisville & Nashville System is located near the west end of the transfer table. This storehouse receives and delivers all store supplies to and from the shop, by the use of the transfer table and small cars. It is also located to permit of easy switching from the belt line to either side of the storehouse. This enables the store department to receive all shipments of material from the outside in carload lots and redistribute it in like manner. A large oil station is provided, directly west of the blacksmith shop. It has capacity for sixty days' supply of oil for the Louisville & Nashville System, north of Nashville. A supply of 30,000 gals. of crude oil is provided, as this fuel is used largely in the smith shop and brass foundry.

The plant occupies a tract of 55 acres, 12½ of which are under roof. The buildings are arranged and designed to secure north light and avoid direct sunlight in the buildings, this being an important consideration in the latitude of Kentucky. They are also arranged to take advantage of the southern breezes, an important feature during the summer months. The plant was laid out and the equipment selected and arranged by Mr. Theodore Curtis, superintendent of machinery. The buildings were designed and their construction supervised by the engineering department of which Mr. W. H. Courtenay is chief engineer, under the direct charge of Mr. J. Werness, principal assistant engineer.



TRAVELLING CRANE AND STORAGE YARD.

(To be continued.)

FREIGHT CAR CONSTRUCTION AND ITS COMMERCIAL ASPECT.

BY L. H. TURNER.

To the man who has been more or less closely allied with car construction and maintenance for over a third of a century the subject presents many interesting and oftentimes amusing features. The car builder of thirty-five years ago made but little use of the technical assistant, and, in fact, but few technical men were employed in the work. Testing machines and laboratories were scarcely known, and the trained eye of the mechanic was the gauge of strength and utility. The commercial side of the question did not receive the consideration it does to-day when the greatest effort is made to obtain the lowest possible light weight with the maximum carrying capacity. The introduction of malleable castings and pressed steel shapes in modern cars has worked wonders in adding to the earning capacity and reducing the total weight of train load, and while a wonderful improvement has been made in the general construction of freight car equipment, we have been inexcusably blind to some points that should have been seen years ago.

The modern steel car, the highest type of freight-carrying vehicle, has been built and probably will continue to be by some, equipped with the M. C. B. twin spring draft gear with a capacity of 38,000 lbs., and then placed behind locomotives with a tractive power ranging from 40,000 to 50,000 lbs. This is one of the results of not giving consideration to what the car is to be subjected to after it leaves the hands of the builder, or of leaving the design to some one not familiar with service conditions, either of which is disastrous to the car owner.

We overlooked another matter when we specified the twin spring gear, viz.: that steel center sills do not have the shock-absorbing capacity of the old wooden car, and that when the weight of the impact exceeds 38,000 lbs. something must take care of the balance. The coupler usually provides the means. If the coupler is strong and the sills somewhat light, then the sills bulge and a few similar jolts put the cars on the shop track.

It is no exaggeration to say that the weak point of the all steel car or the steel underframe car is the center sills, or what might be more nearly correct, that the designer's weak point was his failure to recognize the fact that while the steel sills were amply strong to stand all pulling tests, they lacked the elasticity to stand the strain placed upon them while being handled in gravity yards or under other conditions where the treatment is beyond what is ordinarily expected of a car.

This liability to damage can and should be corrected by the application of friction draft gears and buffer blocks. We believe that the M. C. B. Association erred in not fostering and encouraging the use of buffer blocks either in the solid casting or the spring design, which is far more preferable, as they not only distribute the shock over more of the end of the car, but about double the spring capacity. Friction gears are a necessity and are productive of a great saving, and when used in connection with a spring buffer on steel cars will save and earn more than any other device that can be purchased for the same amount of money.

This fact was quite clearly shown by some observations recently taken in which one lot of steel cars equipped with one pattern of friction draft gear showed a coupler breakage of 18.5 per cent. of all on the cars so equipped. Another friction gear showed 6.9 per cent., while a mixture of wood and steel cars with twin spring attachments and in some cases spring buffers had a percentage of 1.7 per cent. It should be stated that the spring buffers were all on steel cars, indicating that buffer springs and wood are very good mediums for absorbing shocks.

While it must be conceded that the friction gears are of much help, they still do not give the same assistance as is rendered by the wooden car in absorbing the shock, and this seems to prove that something more is needed, and we know of nothing better than the spring buffer.

We have also been blind, generally speaking, to the importance of a proper center plate and side bearing. We seem to have forgotten that the same company that purchases the car has to pay the cost of hauling it, and we have built up a largely increased percentage of train resistance due to center plates of improper design, truck and body bolsters so weak as to place the greatest part of the load upon the side bearings, which of necessity must bind the truck upon the track, resulting in increased train resistance, worn flanges, worn rails, increased expenses and decreased earnings, all of which might be largely eliminated by the use of some of the devices upon the market which will to a great degree remove the friction between the car body and truck, and while it is deplorable to have to admit it, it must be confessed, meritorious appliances are often turned down because they are not the product of our own brain or at the direction of some officer who is always haunted by the phantom of "First Cost." The head of the car department of to-day must roam outside of department lines and be as zealous in considering the ultimate results and the wisdom in adding to the first cost of the car in order that he may reduce the cost of maintenance and get more miles per year out of it, due to the lesser number of trips it makes to the repair tracks, as he is in following time honored traditions and gratifying his personal hobbies.

The office of the head of the mechanical department in this progressive age presents as many opportunities for working out great economies as any other employed in railroad operation, and fortunate is the road who has a mechanical head who can look above the mechanical details and recognize the fact that the car represents the earning power of the company, and is not simply a vehicle capable of sustaining a given load. The most necessary adjunct to the clear-headed mechanical man is the superior officer or purchasing power who has confidence in his ability and honesty to decide as to what type of construction will in the end prove to be the most economical and bring about the best results to the stockholders.

It is gratifying to observe that the policy of buying cars on a question of price alone, regardless of whether it would require six or ten pounds of power per ton to move them or whether they would be serviceable for five or fifteen years, is being relegated with many others that have proven to be unwise.

In confirmation of the wisdom of giving the closest attention to car construction in the way of using the lightest materials of the greatest strength in order that the revenue load may be increased to the highest per cent. of the total weight of the train, also that all pains be taken to reduce the rolling friction to the least possible draft upon the locomotive, a few figures may well be presented showing the comparative earning value of the modern steel car of 100,000 lbs. capacity costing $1,200 and the up-to-date locomotive of 40,000 lbs. tractive power costing $16,000. The car loaded to its capacity with the usual 10 per cent. excess at $0.006 per ton mile, earns $33 for each 100-mile haul. The locomotive with the liberal allowance of 500 tons of revenue freight per train earns $300 for the same distance. The cost of the car is but 7.5 per cent of that of the locomotive, and while the cost of maintenance of the car is less than one cent per car mile, the locomotive requires at least six cents per engine mile. Placing the life of both at fifteen years, you will have expended on the locomotive for first cost and maintenance (assuming it runs 100 miles per day) $48,850, and it will have earned $1,642,500 or 3362.3 per cent. on the capitalization, while the car will have cost $2,295, and will have earned $36,135, or 1574.5 per cent on the capital invested.

Owing to traffic and other conditions, cars only average twenty miles per day, and this might be regarded as a suggestion to the transportation departments that the most fruitful source of increased earnings is by increased mileage of freight cars. The figures given above plainly show that if by a reduction of terminal and shop track delays the car can be made to make forty miles a day, that its earning on the

capital invested will nearly equal that of the locomotive, which will further strengthen the argument that it is money well invested in bringing the car up to the same standard of efficiency and economical operation as the locomotive, and that the same pains be taken to keep it moving.

New trade conditions make it necessary that the car of to-day shall fill more requirements than those of the past. It must be capable of carrying a greater variety of commodities, and thus avoid deadhead mileage. It must be constructed so as to be loaded with the least possible cost to the shipper of pipe, structural steel, lumber, etc. This is particularly true of the twin hopper steel gondola, which must be made available for pig metal, billets, and similar material, and the hopper door fastenings must be of a design which will prevent absolutely any loading working out and causing damage to its own or other trains. When the necessities already recognized and those which will be seen are complied with, the freight car will take the place it deserves, viz.: on a basis of equality with the locomotive as an earning factor.

STANDARDIZING LOCOMOTIVE EQUIPMENT.

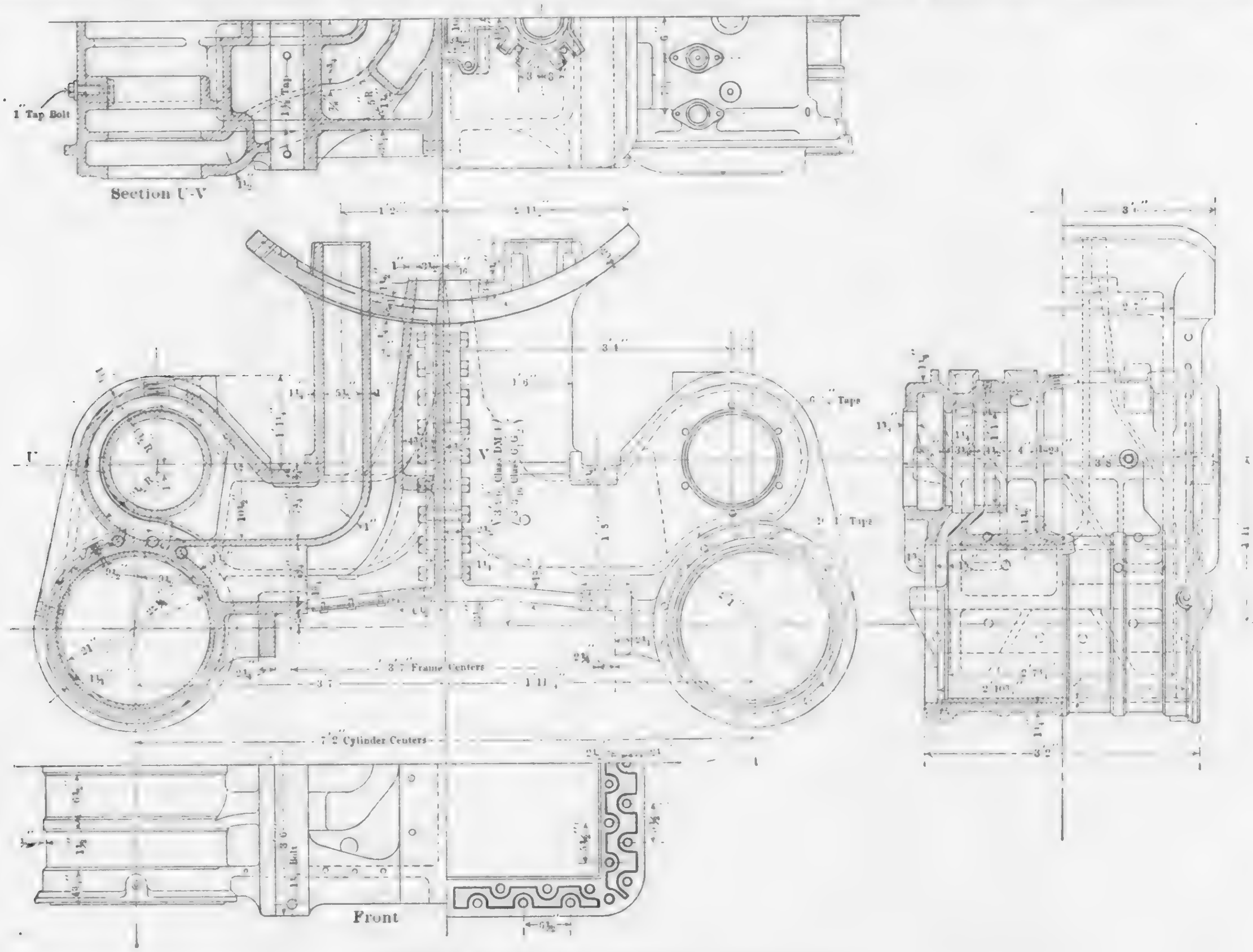
CANADIAN PACIFIC RAILWAY.

III.

In the previous articles, on pages 126 and 161, the very broad application of the standard locomotive parts recently adopted by the Canadian Pacific Railway for use on the three types of standard engines, viz., Pacific, ten-wheel and consolidation, was pointed out and a general description, with dimensions, of the typical classes of each type was given. In this and later articles will be shown a number of the more interesting details which are common to the standard engines as well as, in many cases, to a large number of locomotives not considered as standard. In considering these it should be remembered, as was stated in the first article, that it was advisable, as far as possible without affecting their value for future work, to retain many old parts which had been satisfactory and could with small change be made to serve on several different classes.

Cylinders.—All of the standard engines have 21 by 28-in. simple cylinders with piston valves, and a design has been adopted which is interchangeable with classes M4, D10 and D11 and differs from the cylinders used on the classes G1 and G2 only in the height and radius of the saddle. This design is shown in the illustration.

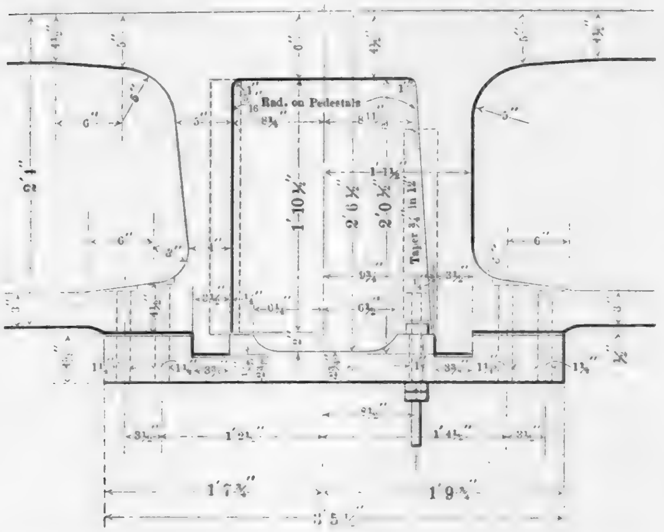
Piston valves with inside admission are used and the steam is brought to the valve chamber through a direct passage. It is exhausted at the ends through passages with liberal area and easy bends, which are separated from the live steam passage by a wide air chamber at all points. This feature is of special importance where superheated steam is used. The valve chamber is somewhat longer than the cylinder in order to allow an almost direct steam port, the extension at either end being taken up by the exhaust passage. The casting is made for use with a ⅝-in. cylinder bushing and has 1¼-in. cylinder walls. The arrangement is for a double bar frame spanning the cylinder, the top rail being fastened by four 1⅜-in. vertical screw bolts and the bottom rail by six 1½-in. horizontal bolts through the lower flange and two 1¼-in bolts at the ends. Both rails have deep shoulders at both ends of the cylinders and are further secured by keys.



STANDARD CYLINDERS—CANADIAN PACIFIC RAILWAY.

Frame Details.—The principal features of the frames which have been standardized are the pedestals, shoes and wedges

and pedestal binder. Since the cylinders, as far as the frame fits are concerned, are in duplicate on the five classes, it follows that this portion of all frames is the same and comprises two rails, the upper being 4½ by 5 ins. and the lower 4½ by 6 ins. in section. The main frames, of cast steel or wrought iron, are 4½ ins. wide and have a depth of the upper rail varying from 4½ ins. between pedestals to 6 ins. over pedestals.



STANDARD PEDESTAL AND BINDER—CANADIAN PACIFIC RAILWAY.

The illustration herewith shows the standard pedestal for the main drivers with its binder. This differs from the other pedestals only in width, being ½ in. wider on either side of the center, or an inch total. The strap binder is finished for ⅛-in. draw, and is held by two bolts at either end passing through the frame. The simple design of wedge adjustment is clearly shown in the illustration.

Driving Boxes.—A special design of cast-steel driving box has been adopted in two sizes, the 9½ by 12 for main drivers and 9 by 12 for others. These boxes are used on 143 engines outside of the standard classes. The illustration shows the larger box, the other being similar except for dimensions in connection with the smaller journals and narrow pedestals. It will be noticed that the box is a simple straightforward design, and has a brass of 1⅞ ins. in thickness at the crown, held in place by two ¾-in. brass pins in the center. Two longitudinal oil grooves ½ in. square in section are milled for nearly the full length of the brass at about the 45-deg. line on either side and are connected by diagonal grooves, of a smaller section, from either end. Two ¾-in. oil holes on either side extend from these grooves to the top of the box. A ⅜-in. bronze liner is riveted at the bottom of the shoe and wedge fit, and a ¼-in. babbit plate cast onto the box gives a bearing against the hub. The cellar is of cast iron and has an opening covered with an iron plate on an inclined portion of its inner side, which allows the packing to be renewed and inspected without taking down the cellar. The other details of the box are clearly shown in the illustration.

(To be continued.)

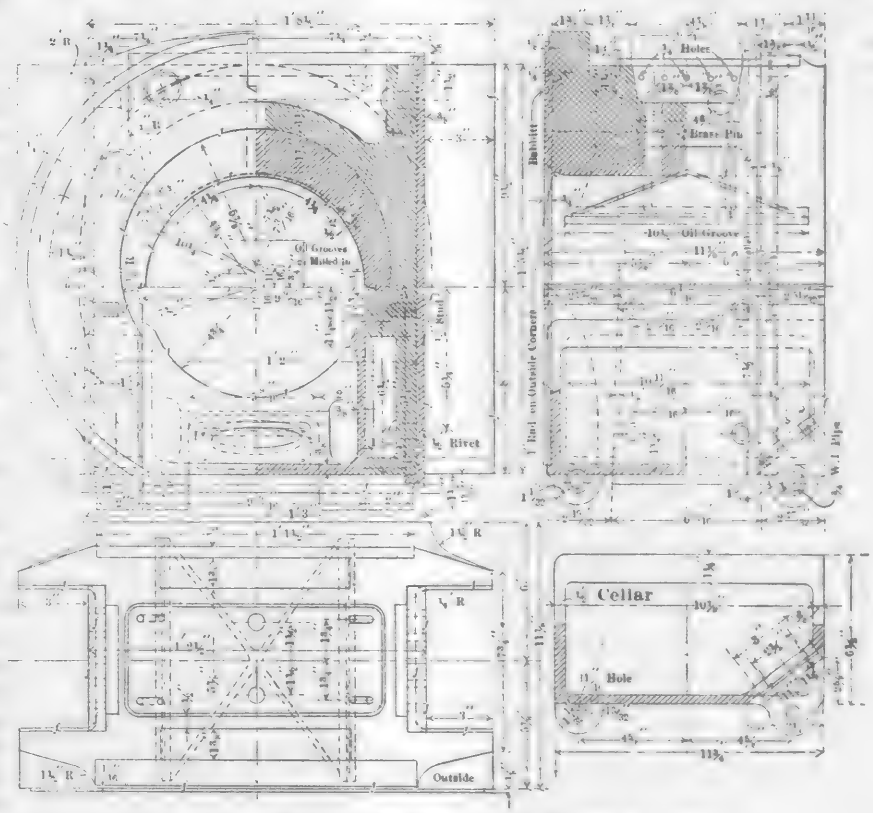
KAISERIN AUGUSTE VICTORIA.—This is the name of a new Hamburg-American ocean liner which is 700 ft. long, 78 ft. beam, and has eight decks above the water line. Her displacement is 43,000 tons, and a crew of 550 officers and men will be carried.

IMPROVING THE MACHINE SHOP OUTPUT.

BY C. J. MORRISON.

To increase the output of the machine shop the builders make heavier machine tools, the shop experts design special jigs and tools and the steel makers turn out steel to cut at speeds unheard of a few years ago, but little attention is paid to the source of all output—the power. What good is the heavy machine, the special jig and the high-speed steel if there is a deficiency in power? Of what practical value is a machine capable of turning out a piece of work in thirty minutes if it is only supplied with power enough to do the work in an hour? Most of the direct-driven machines are supplied with sufficient power to drive the cut, but fall down on the feed. There are also a number of widely advertised machines supplied with motors of sufficient power and transmissions which can carry only one-third or one-half the power of the motor.

It is the machines which run in the groups, however, that are the worst sufferers. We find machine after machine supplied with such narrow pulleys for belts that they can only be run at a small fraction of their rated capacity, and even then suffer many serious delays through belt failures. This happens even in shops where the belt receives the best possible care and only first quality belting is used. Not only are the belts themselves unable to transmit the power required, but the excessive tension at which they must be run heats the journals, and in some cases has actually sprung the shafts. A machine built the last month of 1905 requires 12 to 15 h.p., and is equipped with a belt which, when strained to its utmost capacity, can transmit only 6.4 h.p. Even at this horse power the belt is strained beyond the point where it can give service free from failures.



STANDARD DRIVING BOX—CANADIAN PACIFIC RAILWAY.

A very great saving may be made by equipping the machines with pulleys of the proper width and by giving proper attention to the care of the belts. The saving is threefold; first, time saved by cutting out loss of time due to belt failures; second, in the actual cost of belt maintenance; and, third, in the increased output due to running the machines to their full capacity. In a shop using 1,500 belts a belt foreman was ap-

pointed, a belt room installed, and a regular system of caring for belts established. The result the first year was almost startling. Failures were reduced from 375 per month, with an average delay of thirty minutes each, and often delaying 10 to 20 men, to 44 per month, with an average delay of five minutes each, and never delaying over two or three men. By a failure is meant any belt trouble which delays a workman. The expenses were reduced 90 per cent., and showed an actual money saving sufficient to buy and install the finest wheel lathe on the market. At the same time, partly due to the belts and partly to other causes, the output of the shop was increased over 100 per cent. This was accomplished in spite of the fact that many of the machines had pulleys of inadequate width. Had all the pulleys been the proper size the failures could have been reduced to about 15 per month, the expenses reduced 95 per cent., and the output increased 10 to 15 per cent. more.

These points are well worth the consideration of machine tool builders and shop superintendents. A machine deficient in belt power should not be purchased at any price. Neither should belts be allowed to take care of themslves. One hears in every shop: "Belts are cheap. Tear up the belts and turn out the work." This is a mistake. Belts are expensive. Poor belts cost more than good ones. Properly caring for the belts increases the output and saves money.

A machine should not be accepted which has a weak or poorly designed feed arrangement. There is no advantage in taking a heavy cut and an infinitesimal feed. A number of the latest machines have had the entire feed arrangement rebuilt within a month after being put to work on account of breaking or slipping under a heavy feed. This not only caused a direct money loss, but the high-priced machines were piling up surcharges which made their future work expensive. In fact, in some cases it would have been cheaper to have performed the work at a slower speed on the old machines which had been discarded as out of date.

THE ST. LOUIS LOCOMOTIVE TESTS—PENNSYLVANIA RAILROAD.

By G. R. Henderson.

The report of locomotive tests at the Louisiana Purchase Exposition, prepared by the Pennsylvania Railroad System, is very comprehensive and contains a great amount of valuable matter that has never before been presented to the public, and it is with some hesitation that I attempt to make any resumé of this elaborate work.

At the end of the book are found a half dozen pages entitled "Summary of Conclusions," and these give in a nutshell the general results of the tests. There are some further points, however, which are of great interest to motive power men, and while it must be distinctly understood that there is no attempt being made to include even a large portion of the vital points which are exploited in this report, yet it seems as if it would be interesting to lay particular stress upon a few of the subjects which have heretofore excited considerable comment and conjecture as to their actual value in connection with locomotive performance.

* * * * *

Amount of Coal Fired.—In the first place, the amount of coal that was fired on these engines is of interest in connection with the enlarged grate areas and heating surface of modern boilers, and the complaints made at different times that it would be difficult to obtain a fireman whose capacity was equal to getting the full amount of work out of the firebox. On page 122 we find the statement that the work of firing imposed at all times a severe task on the fireman, and that it would be realized more fully when it is considered that he often had to fire continuously for three hours and maintain approximately the maximum steam pressure, not having the benefits of the short periods of rest afforded in actual service by descending grades and sidetracks. It is further stated that in some of the tests there were fired 6,700 pounds of coal per hour, and, notwithstanding the fact that two firemen were provided, when hot weather came the fireman on one occasion fainted, and it was necessary to provide fans in order to introduce cooling air, which in road service is obtained by the motion of the engine. In the last month of the test the work became so heavy that a third fireman was necesssary.

From this statement it appears that the limit of one fireman was practically reached by the consumption of fuel upon the engines on this plant, and it will be interesting to note the amount of coal burned per square foot of grate area per hour due to this quantity of fuel.

We give below a table showing approximately the general results of these tests, from which it appears that, as stated before, the maximum coal consumption, or really the maximum amount of coal fired, was 6,700 lbs. per hour. As this was with an engine having quite a large grate, that is, 50 sq. ft., the rate of combustion per square foot of grate area was only 134 lbs. per hour, and we have, in the case of engine 734, a somewhat higher rate, viz.,

	Coal per Hour		Per Sq. Ft. of Grate		Grate	Max.
Engine No.	Min.	Max.	Min.	Max.	Area.	Draught.
628	1000	3500	34	121	29	3.7"
2512	700	3000	21	91	33	3.5"
734	1100	4700	33	140	34	5.9"
535	900	5800	18	120	48	6.7"
1499	1100	4200	22	86	50	4.7"
585	1000	2800	20	56	50	3.7"
3000	1300	6700	26	134	50	8.9"
929	1100	4300	19	74	58	3.7"

140 lbs. per square foot of grate per hour, the draught in this case being 5.9 ins. of water in the smokebox, whereas with engine 3000 the draught was 8.9 ins.

We all know that this rate of combustion and this amount of draught are frequently exceeded in ordinary practice, as it has been shown at different times, not only in road service, but also on other testing plants, that the rate of coal combustion may amount to 200 lbs. per square foot of grate per hour. We also know that the draught gauge will frequently show 12 or 13 ins., which would correspond to a rate of combustion in the neighborhood of 200 lbs. The formula which is used to indicate the ratio or proportion between the coal consumed per square foot of grate surface per hour and the draught in inches of water in the smoke box, approximates .05, or the draught equals 1/20 the number of pounds consumed per square foot of grate per hour; that is, a rate of combustion of 200 lbs. would require 10 ins. of draught in the smoke box. This is not very far from what we also find in stationary practice, where a rate of combustion of 20 lbs. per square foot or grate requires very nearly 1 in. of draught at base of the chimney. It is evident, therefore, that none of the locomotives which were run in these tests were forced to the ultimate limit of their firebox capacity. There are reasons for this, and very good ones; one, owing to the fact that if the full power of the locomotive was obtained at slow speeds, there was continual slipping of the wheels and a very irregular action of the brakes, due to rapid fluctuations in the water pressure which controlled the Alden brakes. On the other hand, at high speeds the vibration of the engine was so great that it was impracticable to reach, in some cases, the limit of the boiler. These results would seem to show that there is now actually a need for a good locomotive stoker which can handle quantities of fuel far in excess of the capacity of the ordinary fireman, and that the demand for such a stoker is liable to increase rather than decrease with the large-sized boilers that are now used. If, however, it is considered advisable to still fire these locomotives by hand, it is quite evident that we cannot get the full power out of the locomotive which would be possible if we could supply the box with larger quantities of fuel.

* * * * *

The Quality of the Smoke Box Gases is something that gives us rather a surprise, as it is a popular opinion that locomotives are not only wasteful in fuel, but also give very

imperfect results from the combustion of the fuel. We find, however, that the percentage of CO_2 was very nearly as good as will be found in first-class power plants and better than will be found in a great many. While in different cases the amounts were something like this: 9.8 to 13.0, 10.6 to 13.3, 6.9 to 12.9, 12.0 to 14.0, the averages varied between 10 and 13 per cent. of CO_2 for the different locomotives tested, the actual averages being represented by the following figures: 10, 11, 11, 12, 12, 12, 12, 12.5 and 13. These results can certainly not be considered as at all unfavorable for the analyses of smokebox gases of a locomotive, and show us that many of the conclusions regarding the imperfect combustion of fuel in the locomotive are erroneous.

In connection with the percentage of CO_2 the efficiency of the boiler is a natural sequence. Of course we know that there are many cases when large quantities of fuel are rejected in an unburned condition from the smoke stack, but there are many times when the ordinary service conditions are quite conducive to economy. For instance, the following table will show the efficiency of the boiler at minimum and maximum coal rates, also the average of the different runs:

At Maximum Coal Rate.	At Minimum Coal Rate.	Average Efficiency.
45	79	60
42	71	55
60	78	68
54	74	65
51	78	65
44	78	63
39	63	60
47	75	63

The average efficiency of the boiler in these tests will therefore be found in most cases above 60 per cent. In only two cases did the average fall below this figure. With stationary boilers in first-class order and regulation settings with every convenience to obtain good results from the use of fuel at comparatively low rates of combustion, the efficiency will not often run over 70 per cent., and here, again, we have the second surprise, in that, even considering the great steam capacity of the locomotive boiler, its efficiency is only about 10 per cent. less than that of the average first-class stationary boiler.

* * * * *

THE MACHINE EFFICIENCY is a third surprise, at least it will be to those who have held the view that at high speeds the locomotive absorbs nearly all the energy which it produces; that is, that it could haul very little besides its own weight, due to the internal friction of the engine. Of course it must be borne in mind that in the case of these tests there were no head winds to be encountered; there were no grades to surmount, but the rolling friction and the friction of the parts of the interior mechanism of the engine were present probably just as largely as they would be under conditions of road service. The machine efficiencies from the general tests, roughly grouped, are about as follows:

At. Min. Draw-bar Pull.	At Max. Draw-bar Pull.	Max. Efficiency.	Aver. Efficiency.
77	77	82	78
90	78	94	88
92	79	94	86
81	88	90	85
89	75	89	80
85	79	88	80
94	83	94	88
93	68	94	88

These efficiencies are all certainly very favorable to the machinery of the locomotive, as they are all practically 80 per cent. or over on the average, and in some cases have reached as high as 94 per cent. Engine 3000 was the only one which they were able to run at 320 revolutions per minute or 75 miles an hour, and at this speed the efficiency was 78 per cent.. It is noted in the comments that the loss of power between the cylinder and the draw-bar is greatly affected by the character of the lubricant, and it appeared from the tests that the substitution of grease for oil upon axles and crank pins increases the machine friction from 75 to 100 per cent.

When we consider the combined efficiency of the boiler and the machine, we are prepared for the comments which are made, as follows:

"It is a fact of more than ordinary significance that a steam locomotive is capable of delivering a horse power at the drawbar upon the consumption of but a trifle more than 2 lbs. of coal per hour. This fact gives the locomotive high rank as a steam power plant."

We think that this testimony of the committee in their conclusions is one of great interest and importance, and that it will stand as a monument to the much maligned locomotive as a steam generator and prime mover.

* * * * *

THE QUALITY OF THE STEAM furnished by the boiler is also much better than has been ordinarily expected. Of course, it must be borne in mind that the locomotive was standing on the test plant, and it is possible and probable that the foaming or priming was not as great as would be the case when running over a railroad track more or less rough. It is rather surprising, however, that the quality of the steam, as shown in the dome, varied between 94 and 100 per cent.; that is, that there was less than 6 per cent. moisture in the worst cases, and the average showed that the moisture was not over 1½ per cent. When the steam advanced into the steam pipe, the super-heat, due to wire drawing, reduced this amount 1 per cent., so that the average quality of steam in the branch pipe was about 99½ per cent. of dry steam. This is certainly a very interesting result and one that was hardly expected.

* * * * *

THE EVAPORATION PER POUND OF COAL was very satisfactory. It is true that a good quality of coal was used, it having been uniformly obtained from the Scalp Level Mines, near Johnstown, Pa., and had about 76 per cent. fixed carbon and 7 per cent. of ash. The uniformity of the results is very apparent by a diagram published in the report in which the evaporation of water per pound of coal varied about as follows, for different rates of combustion, per square foot of heating surface per hour:

Rate of Combustion.	Minimum Evaporation.	Max. Evaporation.
.5	10.5	12.0
1.0	8.5	10.0
1.5	7.0	8.5
2.0	6.0	7.5

It will be noticed that for all the tests of the different locomotives the variation between the evaporative rate was only 1½ lbs., at rates of combustion from ½ to 2 lbs. of coal per square foot of heating surface per hour, and we can assume that for fuel of this quality the evaporative efficiency is almost sure to fall within these limits.

With the information above given, we can construct another table showing the pounds of water per square foot of fire heating surface per hour, due to the maximum evaporation and the rates of combustion above selected:

Pounds of Steam per Sq. Ft. of Heating Surface per Hour.

Rate of Combustion.	Maximum Evaporation.
.5	6.
1.0	10.
1.5	12.8
2.0	15.

While the evaporative efficiency is generally greatest when the rate of combustion is least, as indicated by the previous table, yet it is seen that under the conditions which existed in these tests it was possible to obtain 15 lbs. of steam per square foot of heating surface per hour, this heating surface being measured on the fire side of the tubes, and if we consider a horse power to be represented by 34½ lbs. of steam from and at 212 deg., we find that a horse power was developed at the maximum rate of combustion from a little over 2 sq. ft. As, however, the engines in many cases used less steam per indicated horse power per hour than this amount, there is absolutely no difficulty in obtaining an engine horse power from 2 sq. ft. of heating surface. It has been customary to consider that foreign locomotives running without diaphragms or obstructions in the smoke box are much

more efficient in the use of fuel than American locomotives, in which the obstructions placed in the smoke box necessitate a higher back pressure and a greater smoke box vacuum. It is interesting to notice, however, that the two engines which had no diaphragm in the smoke box (Nos. 628 and 2512) actually gave the lowest evaporation per pound of coal.

Assuming that 34½ lbs. of water represents a horse power as stated above, the different engines delivered the following proportions of a horse power per square foot of heating surface: .36, .35, .28, .29, .26, .41, .35, .47. These figures are slightly less than the value which Prof. Goss found on his Purdue testing plant, where he found that 1 sq. ft. of heating surface was equivalent to .43 h.p. In this case, however, Prof. Goss considered that 28 lbs. of steam was sufficient for a locomotive horse power, which, if followed in the present case, would give figures very closely agreeing with Prof. Goss' assumption.

The maximum indicated horse powers given by the locomotives under test vary from 816 to 1641. The freight engines gave horse powers varying between 1041 and 1258, so that the passenger engines show the greatest variation, the largest horse power being given by engine 3000, which was the Cole compound Atlantic type. These horse powers were obtained by indicator diagrams from the cylinder, and in connection with the steam generated and the horse power delivered, it is interesting to determine the amount of steam used per indicated horse power per hour. We find that the simple engines gave a minimum steam consumption on the average of 23.7 and a maximum of 29.0. These figures are better ,as a rule, than the allowance of 28 lbs. above quoted from Prof. Goss. It is also interesting to discover that the most economical cut-off for the simple engines, at the various speeds at which the engines were run, was found to be 30 per cent. nominal; that is, when the valve cut off the steam at 30 per cent. apparent cut-off, no matter what speed, the engine was being run at the best economy.

The compound engines gave a minimum water rate of 18.6, and a maximum of 27.0. It was here found that the most economical cut-off ranged from 35 to 50 per cent. on the high-pressure cylinder, the ratio between low and high pressure cylinders in these engines varying from 2.3 to 2.8. These water rates are not at all abnormal, but are what have frequently been found in actual road tests on similar engines, and indicate very concisely what may be expected under service conditions with simple and compound locomotives.

* * * * *

Tractive Force.—It is to be regretted that large tractive forces were not developed on the test plant. The reason for this was that owing to the fluctuations of water pressure used for controlling the brakes, it was impossible to work the engines at slow speeds and long cut-offs, as there was constant danger of stalling the brakes and slipping the wheels, and it was therefore found impossible to construct directly for the different locomotives diagrams showing the maximum draw-bar pull at all speeds. An attempt was made, however, to show what might be expected under the conditions in which these engines operated, but they cannot be taken as an index of what would be obtained in actual service. We must also bear in mind that the limitations of the fireman prevented the use of fuel to an extent which would be possible under heavy draught conditions, and that these two facts mitigated against obtaining the maximum tractive force at slow speed.

As an illustration of this we will consider briefly the tractive force which could ordinarily be expected and what was actually obtained. In determining the maximum tractive effort which the engines would be capable of giving, the formula

$$\text{Tractive force} = \frac{.8pd^2s}{D} \text{ was used,}$$

where p = the boiler pressure; d, the diameter of the cylinder; D, the diameter of the drivers; and s, the stroke of the piston; the dimensions being in inches and the pressure in pounds. For compound engines the proper allowance was made for the ratio of cylinders. It was found that in no case did the actual draw-bar pull, as measured by the dynamometer, anywhere reach the tractive force as determined by the formula, but it must be noticed at the same time that the point at cut-off was very much less than it should be in order to obtain the full tractive effort. The formula above given ordinarily considers that the reverse lever is carried in the corner notch, with a cut-off something between 80 and 90 per cent., and bearing this in mind the figures given below will help us to reach an understanding as to why the full draw-bar effort was not realized:

Calculated Trac. Force.	Max. Aver. Trac. Force.	Per cent. cut-off.
39,773	22,078	37.
33,616	24,522	41.
31,838	24,539	57.
63,612	31,240	51.
16,700	8,615	35.
19,245	12,815	53.
13,789	9,016	45.
20,590	12,780	54.

In the table the first two engines listed are single expansion locomotives, while the last six are compounds, the cut-off given as of the high-pressure cylinder. From these points of cut-off it is not only evident that the full draw-bar pull could not be expected, but it is also evident that the full rate of fuel combustion was not obtained, especially at the slow speeds. The figures given, therefore, as representing the draw-bar pull, do not by any means show what could possibly be hauled upon the road, and while they correspond with many cases that would occur in actual service, yet they do not represent the work of the engine hauling a full train rating up a heavy grade at a slow speed. These points should all be borne in mind in connection with the study of the results of these tests. and it must not be concluded that greater powers or higher speeds could not be obtained in actual service than were obtained during these tests, owing to the causes which prevented full service conditions being followed as explained above.

Transcontinental Speed Record.—Mr. E. H. Harriman, president of the Union and Southern Pacific railroads, traveled from Oakland, Cal., to New York City, a distance of 3,255 miles, in 71 hours 27 minutes, arriving on May 8. This wonderful trip was made by special train as far as Buffalo, from which the Empire State Express was used. The following table gives the distances and times between different points on the trip:

Left Oakland, Cal., 7:33 P. M., May 5.
Left Sparks, Nev., 243 miles, 6:47 A. M., May 6.
Left Green River, Wyo., 714 miles, 10:15 P. M., May 6.
Left Omaha, Neb., 824 miles, 2:58 P. M., May 7.
Left Chicago, 490 miles, 1:25 A. M., May 8.
Left Buffalo, 536 miles, 1:00 P. M., May 8.
Arrived New York, 440 miles, 10:00 P. M., May 8.

Circulation in Locomotive Boilers.—It is generally supposed that the circulation in a locomotive boiler proceeds along the bottom of the barrel from the front end down the firebox front and up the sides and back of the firebox. The author, two or three years ago, fitted a number of vanes in a boiler with spindles passing through lightly packed glands to the outside, with indicators to show the direction of the flow of water. Observations showed that the circulation was generally as stated above, but a little alteration of the firing had the effect of materially changing the direction of the currents and even of completely reversing them.—*Mr. G. J. Churchward, before the Institution of Mechanical Engineers.*

National Machine Tool Builders' Association.—This association, which now includes almost sixty establishments, held its spring convention at Atlantic City, May 1 and 2. The purchaser's price for lathes, planers and shapers was advanced 5 per cent., and of upright drills from 5 to 10 per cent. A paper on the apprenticeship system was presented by Mr. E. P. Bullard, and the question of a minimum profit and cost system was discussed at length.

FOUR-CYLINDER BALANCED SIMPLE PASSENGER LOCOMOTIVE.—BELGIUM STATE RAILWAYS.

SIMPLE FOUR-CYLINDER PASSENGER LOCOMOTIVE WITH SUPERHEATER.

BELGIUM STATE RAILWAYS.

One of the most complete and extensive exhibits of locomotives shown at the exhibition held at Liege last year was that of the Belgium State Railways, which included 13 different types or classes of simple and compound locomotives in several arrangements of wheels and cylinders, and using both saturated and superheated steam. One of the most interesting engines in this exhibit, because of its comparatively new and novel features, was a heavy 10-wheel passenger locomotive, having four simple cylinders arranged on the balanced principle and equipped with the latest design of Schmidt fire tube superheater.

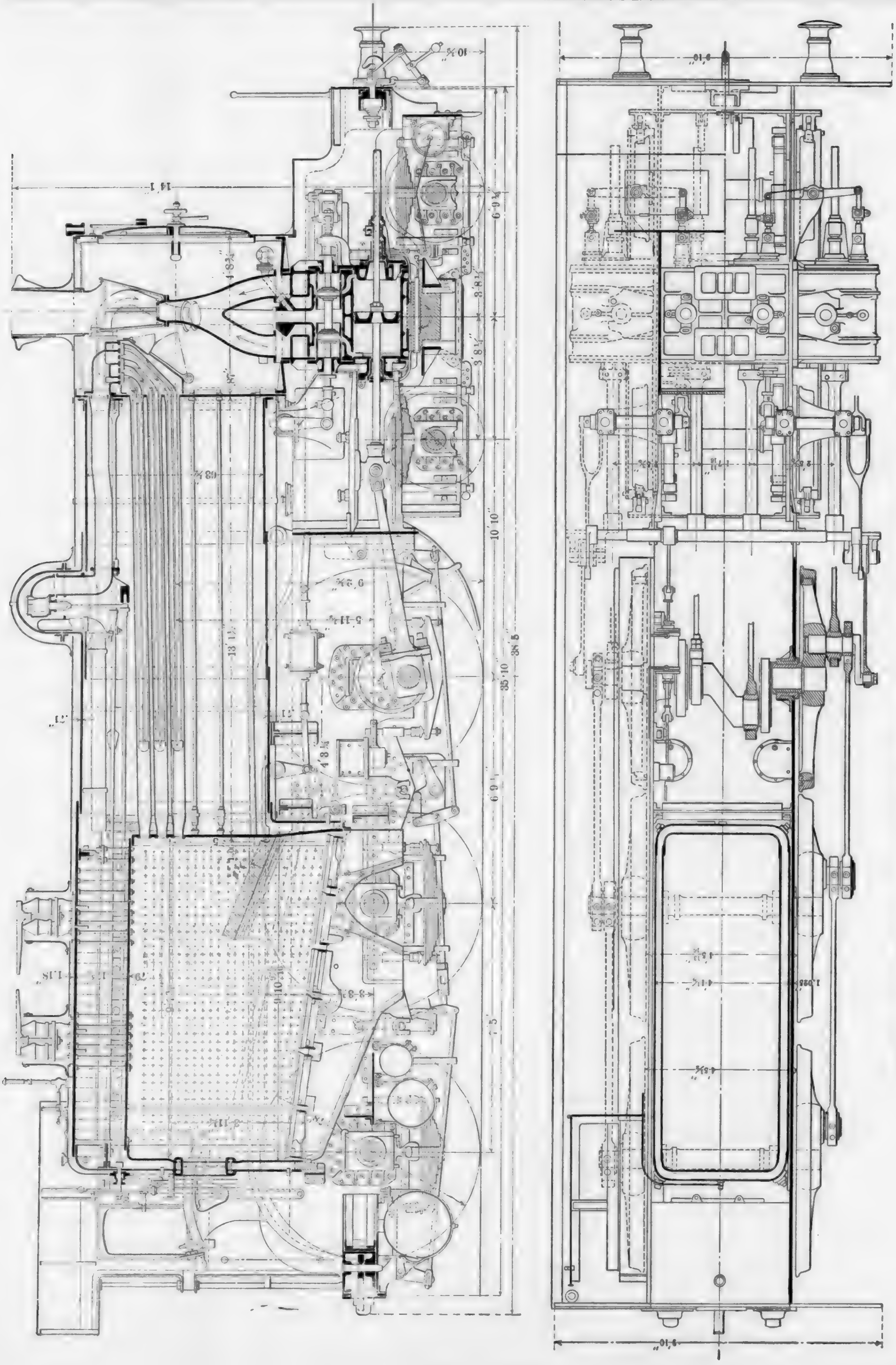
This locomotive, which is illustrated herewith, was constructed by the Societe Anonyme la Meuse, of Schenien, from the drawings made by Mr. Flamme, general inspector, under the direction of Mr. Bertrand, director of the State Railways. It forms one of a group of engines which have been constructed largely for experimental purposes; the others included a four-cylinder simple engine without superheat and four-cylinder balanced compound engines both with and without superheat.

As can be seen from the illustrations, the four equal cylinders are arranged in a line across the center of the four-wheel truck in the same relative position as that used on the Baldwin four-cylinder balanced compound locomotive. All the cylinders are connected to the front pair of drivers, which has a built-up crank axle. The connection is such that the two cylinders on the same side of the engine are at 180 deg. with each other and at 90 deg. with the corresponding cylinders on the opposite side. Inasmuch as all moving parts in both cylinders and the main rods are exact duplicates, it follows that this connection gives an absolutely perfect balance on each side of the engine.

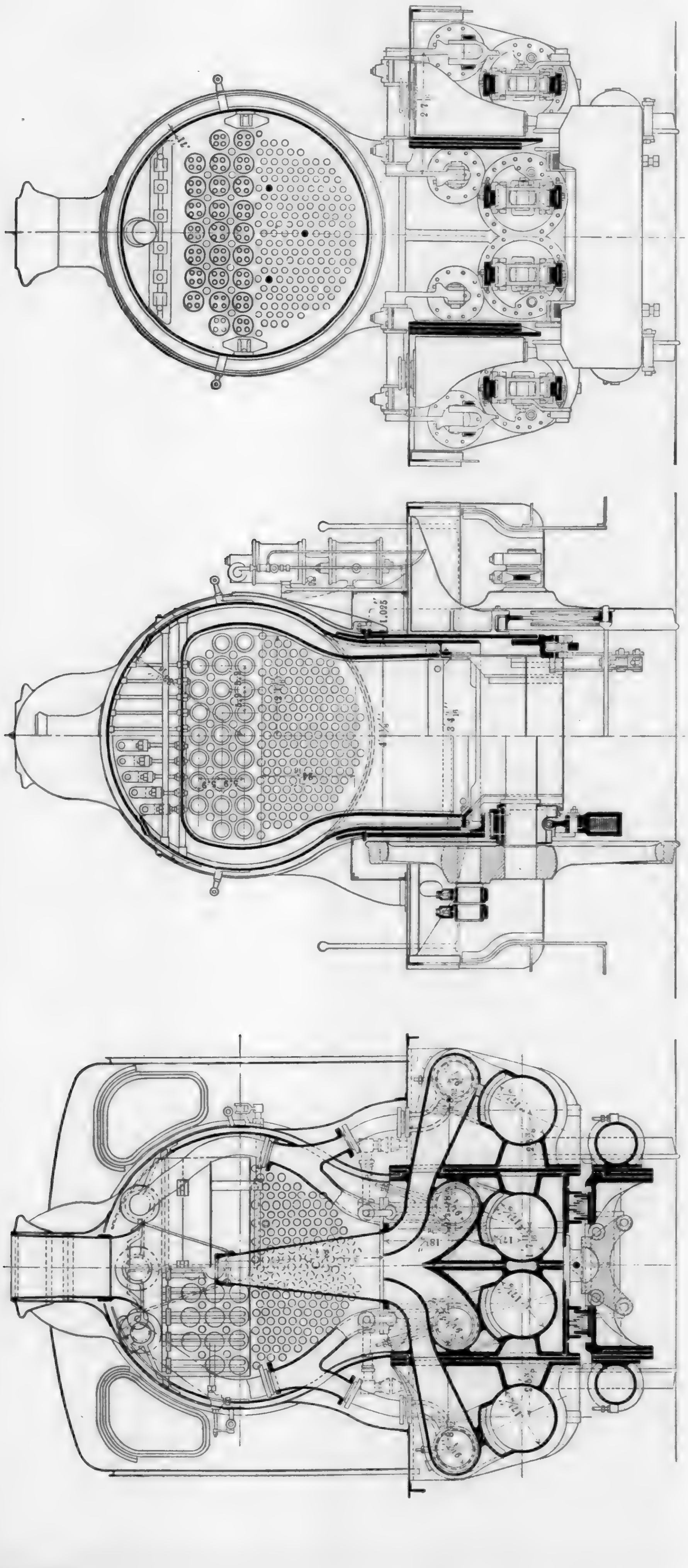
The operation of each cylinder is controlled by a separate piston valve, 7⅞ ins. in diameter, with inside admission; the two valves on each side of the engine being operated by a single Walschaert valve gear. The use of inside admission valves with Walschaert gear ordinarily requires the reversing of the connections of the radius bar and valve rod to the combination lever, in addition to the revolving of the return crank, so that its connection is 180 deg. from its usual position. In this case, however, since the inside piston is connected at 180 deg. with the outside, the valve gear was connected from the outside crank pin and crosshead in the same manner as if it was to operate an outside admission valve on the outer cylinder. This movement is then transferred to the inner valve through a rocker arm, and gives it the correct position for an inside admission valve on that cylinder. This arrangement giving a satisfactory movement to the inside valve, it was necessary to simply connect the outside valve so that it would have an opposite movement. This was done by extending the inner valve rod through the front head and connecting it to the lever which extends across the frame and operates the outer valve through a valve rod extending through its front head. These connections are clearly shown in the diagrammatical view given herewith.

Since each of the four cylinders are operated independently it is necessary to have four separate steam passages to and from the valve chambers. This has been done in a very simple manner, which shows clearly in the cross section through the cylinders, by bringing the regular steam pipes from the superheater head to about half their usual length, where a joint to a Y-shaped steam pipe is made. The two branches of this connect to the different valve chambers. The outer one passes outside the front end and connects through a short pipe with ground joints to the side of the valve chamber. The inner one extends down and connects in the usual manner inside the front end. The cored steam passages inside the cylinder casting for both the exhaust and the admission have been carefully worked out, and in no case does a single wall separate the two passages. This feature is of particular importance in engines using superheated steam, and is one which can be more easily solved when an inside admission valve is used. The four exhaust passages connect to a single exhaust pipe having two broad sections at the base, which join into a single pipe, as is shown in the longitudinal section of the locomotive. This pipe has a 5-in. nozzle.

The boiler, which is similar to American practice in general arrangement, although not in construction, is of the narrow firebox type; the grate area being large as compared with general European practice, although not as large as that



SECTIONAL ELEVATION AND PLAN OF FOUR-CYLINDER BALANCED SIMPLE LOCOMOTIVE.—BELGIUM STATE RAILWAYS.



CROSS-SECTIONS OF FOUR-CYLINDER BALANCED SIMPLE LOCOMOTIVE.—BELGIUM STATE RAILWAYS.

used on some former locomotives in Belgium. This particular locomotive was designed to burn briquetted coal, and hence does not require an excessively large grate. The flues, of which there are 180 of brass, 2 ins. in diameter, and 25 5-in. iron tubes, which enclose the superheating pipes, are 13 ft. 1½ ins. long. This gives a heating surface of less than 1,500 sq. ft. in the tubes, but the firebox, because of the large grate and its depth, gives over 180 sq. ft., or more than 10 per cent., of the total heating surface. The crown sheet is flat and supported by crown stays, and there are also horizontal stays between the outside firebox sheets above the crown sheet. There are four stays between the tube sheets, which are fitted with turn buckles for adjustment. The method of fastening the front tube sheet to the boiler shell is interesting. The flange of this sheet is turned outwards, and to it is fastened the smokebox sheets. The fastening between the boiler shell, which is of smaller diameter than the smokebox, and the tube sheet is by means of a circular angle placed outside the barrel and riveted to both. The front tube sheet, in addition to the four stays to the back sheet previously mentioned, is also further stayed by bars running from a horizontal angle above the line of the flues for the full length of the boiler to a similar connection at the back head. These bars also have turn buckles for adjustment.

The superheater is of the Schmidt fire tube type, and in each of the 25 5-in. tubes there are two loops of iron pipe extending from the steam header, which, all told, give a superheating surface of over 419 sq. ft. The passage of the gases through these flues is controlled by a damper in the front end, which is closed when the locomotive is not using steam. The superheater is capable of giving a temperature of from 570 to 660 deg. F. to the steam, the temperature being varied by the amount that the damper is opened. A thermometer gives the engineer exact information as to the temperature of the steam.

The frames, like all European equipment, are of the plate design, being 1 1-32 ins. thick, and over 30 ins. in depth over the driving boxes, and nearly that at the point just back of the cylinders, which is the narrowest section. The two frames are tied together by vertical cross plates at several different points, and are placed as far apart at the rear as the driving wheels would permit, so as to allow the firebox, which extends down inside the frames, to be as wide as possible.

Cast steel driving boxes are used with filled brass journals. The spring rigging, which is all underhung, shows

clearly in the longitudinal section, and it will be seen that much care has been taken to keep the proper alignment and easy movement of all of this rigging. The springs are carried from a connection to the bottom of the driving box, and are located directly below the box, the equalizers being between the wheels.

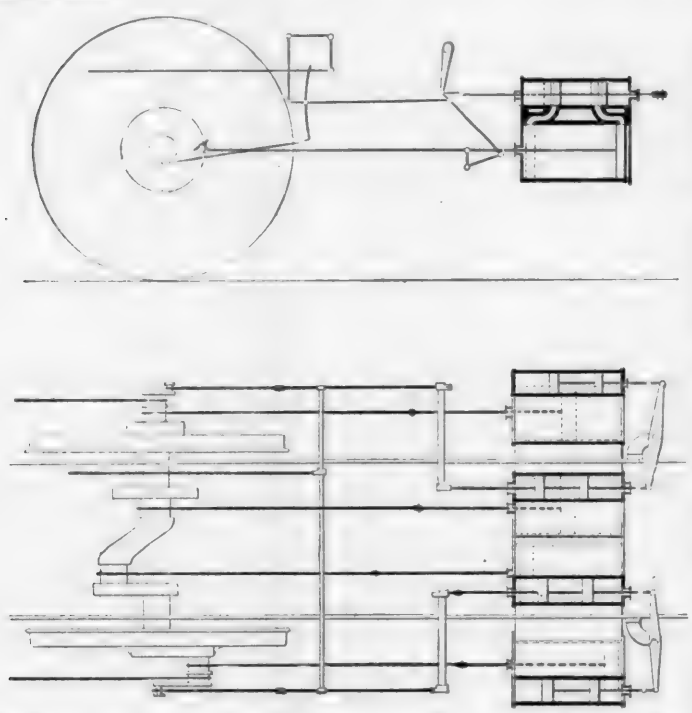


DIAGRAM OF VALVE GEAR.—FOUR-CYLINDER BALANCED SIMPLE LOCOMOTIVE.

The engineer stands on the left-hand side of the cab, as is becoming the practice abroad on locomotives with large boilers. A type of steam reverse gear is used, the cylinder for reversing being located on the inside of the frame just back of the reverse shaft. A combination of lever and screw control of reversing gear is used.

We are indebted to Mr. Flamme, inspector of the Belgium State Railways, for the drawings shown herewith.

The general dimensions, weights and ratios are as follows:

SIMPLE FOUR-CYLINDER LOCOMOTIVE—BELGIUM STATE RAILWAYS.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Briquetts
Tractive effort	31,500 lbs.
Weight in working order	179,300 lbs.
Weight on drivers	115,500 lbs.
Weight on leading truck	63,800 lbs.
Wheel base, driving	14 ft. 2 ins.
Wheel base, total	38 ft. 8½ ins.
RATIOS.	
Weight on drivers ÷ tractive effort	3.66
Total weight ÷ tractive effort	5.7
Tractive effort x diam. drivers ÷ heating surface	147
Total heating surface ÷ grate area	51.7
Firebox heating surface ÷ tube heating surface	12.2%
Weight on drivers ÷ total heating surface	68.9
Total weight ÷ total heating surface	107.
Volume both cylinders	12.8 cu. ft.
Total heating surface ÷ vol. cylinders	131.
Grate area ÷ vol. cylinders	2.53
CYLINDERS.	
Number	4
Kind	Simple
Diameter and stroke	17⅛ x 24
VALVES.	
Kind	Piston
Diameter	7⅞ ins.
WHEELS.	
Driving, diameter over tires	78 ins.
Driving journals, main, diameter and length	7¾ x 10⅝ ins.
Driving journals, others, diameter and length	7⅞ x 10⅝ ins.
Engine truck wheels, diameter	35 7-16 ins.
BOILER.	
Style	St. top.
Working pressure	205 lbs.
Inside diameter of first ring	65 ins.
Firebox, length and width	118.67 x 40.55 ins.
Tubes, number and outside diameter	25-5, 180-2 in.
Tubes, length	13 ft. 1½ ins.
Heating surface, tubes	1494.84 sq. ft.
Heating surface, firebox	181.70 sq. ft.
Heating surface, total	1676.54 sq. ft.
Superheater heating surface	419.27 sq. ft.
Grate area	32.4 sq. ft
Smokestack, height above rail	14 ft. 7 ins.
Centre of boiler above rail	9 ft. 2¼ ins.
TENDER.	
Water capacity	4,400 gals.
Coal capacity	13,230 lbs.

LOCOMOTIVE SHOP MANAGEMENT.

By A. W. Wheatley.

Shop management, to a railroad company, is a subject of great importance, and one which has a considerable bearing on the cost of locomotive repairs. The main repair shop is in reality the manufacturing plant of a railroad. On this account it should be watched and operated precisely the same as a private manufacturing plant.

The private manufacturer is at a great advantage in this respect, inasmuch as he is familiar with the prices of his competitors, and, judging by the values of commodities when placed on the market, adjusts himself to meet competition. With the railroads it is different, because the officers or men operating their plants are not familiar with the cost of manufacture at the shops of their competitors, and comparisons are unfortunately made by the number of engines turned out, and on this account railroads suffer in the following manner: The shop superintendent is frequently informed that a certain shop on a neighboring road is turning out, possibly, 40 engines per month, and he is made to feel that he should exceed that number. Possibly he may have a number of engines in the shop needing very heavy repairs, and in order to satisfy his superiors and not damage his reputation he will reach out and shop engines needing but very light repairs. Frequently engines which could make more mileage are shopped on this account. These engines will be run through in order to obtain a respectable output in numbers, because the efficiency of the plant is judged, not by the cost of repairs, but by the number of engines turned out. The average shop superintendent is at a loss to know what the engines cost the other railroads—which, of course, should be the true basis of comparison.

The railroads are operated to make money, and the output of the shop should be regulated purely from a financial standpoint. To assist in this respect, we must first have a uniform classification of repairs, and the writer offers the following:

No. 1. New firebox, with general repairs to machinery.

No. 2. Side sheets or heavy boiler work with general repairs to machinery.

No. 3. General repairs to machinery, with all flues removed.

No. 4. General repairs to machinery, part flues removed.

No. 5. General repairs to machinery only.

With such a classification adopted generally we can ascertain what it is costing other roads to make repairs, and the efficiency of a shop will then be judged, not by the number of engines turned out, but by the cost of repairs. When the shop superintendent is put up against figures, he will, in turn, put his subordinates up against them, with the result that even the rank and file will know what it costs to do the work.

Because of this the writer feels that in a day work shop the erecting shop should be divided into gangs; each gang covering not more than six pits. Mechanics should be given the engines after leaving the stripping pits and complete the repairs, except for the driver brake, steam pipe and truck work, which should be handled by special gangs. Each month a statement should be published and distributed to all concerned showing the cost of repairs to each engine, by departments; also the cost of material. The gang foreman making the best showing should rank first; the next best, second; and so on down. Those below the aver-

age should be investigated and asked to explain, and coached along, if necessary. Such a system tends to bring about splendid results, both in the saving of labor and material. It makes men familiar with the cost of material used, which to-day in a good many railroad shops is almost unknown. With this system in operation, you are making managers out of your foremen, as well as the machinists themselves. The average man is ambitious and dislikes to be outdone by his fellow-man. If certain engines cost too much, the machinists in turn will have to explain, and if there is no inclination shown to do better, you are justified in dropping them from the service. On this account the above plan is preferred to the "piece gang" system. By this is meant the practice of having certain men do certain work; as, for instance, one gang doing all the frame and cylinder work on all the engines in the shop; another gang doing shoes, wedges and driving boxes. With this system we make specialists instead of managers; it has a tendency to destroy the interest the men should take in their work. Mechanics, as a rule, like to complete repairs to a locomotive, and watch with interest the results when the engine is placed in service. With the "piece gang" system, if the cost of repairs is high, it is difficult to ascertain which is the slow or expensive gang.

In making repairs, the engines after being stripped should be thoroughly inspected, and a schedule should then be made out. The important parts should be scheduled, and every one concerned should receive a copy of it. A daily report should be made showing whether the engines are being repaired on schedule time, and, if late, the cause of delay should be given. Such a report enables the shop superintendent to keep in touch with his entire plant. If delays are caused on account of waiting for material, he should take the necessary action to have it hurried. A common cause of delay in most shops is waiting for tires and other heavy parts, which is very expensive material to carry in stock. It helps considerably in this respect to have monthly reports sent to the shop superintendent showing the physical condition of the power in service. These reports serve to notify him as to what will be required, when an engine is shopped, in the way of tires and wheel centers, also firebox material. These reports should be scrutinized closely and the store department notified. This will help the store department very materially, and will prevent many aggravating delays.

In this connection the mechanical and store departments must get closer together and work more harmoniously; friction between these departments is expensive for the railroad company. On account of not working together, the storekeeper is frequently compelled to carry a very heavy stock in order to protect himself, for in many cases he has undoubtedly been unjustly blamed for not carrying material in stock.

Shop deliveries should be made by messengers, and on no account should mechanics be allowed to frequent the store room. Such a system will require the installation of a private telephone exchange, which no up-to-date shop should be without.

Each gang should have its own complement of tools, such as wrenches, sledges, punches, spring pullers, and pinch and slipping bars. On the machine side there should be a demonstrator, and considerable care must be taken in selecting the proper man for this position. He should be a leader in every respect. Demonstrations should be made and time taken and careful record made of it. These demonstrations will prove which is the best tool to use, and when this has been done, it should be adopted as a standard for the entire road. Machine tools should be kept in the tool room, and all dressing and grinding should be done there.

Care should be taken in locating machines to see that the "lost motion," or carrying of material back and forth is reduced to a minimum; for instance, the machines doing driving box work should be so located that the boxes will pass from one machine directly to another alongside, and not be trucked to another part of the shop. This also applies to rod work and piston work, etc.

The boiler shop should be provided with its own tool room, with a first-class mechanic in charge of tool maintenance. Care should be taken in the location of machines, in relation to the flange fire. Work in this department, on account of its nature, is specialized. The shop should be well provided with jib cranes and hoists. Flue shops should be so arranged that flues, after leaving the cleaner, are placed on cars instead of on the floor or rack, and moved to machines and furnaces in sets. With such an arrangement flues can be cleaned and safe-ended and swaged at a cost of between two and three cents apiece.

The blacksmith shop should be well equipped with up-to-date forging machines, with industrial tracks to each machine to enable unfinished material to be taken from the car to the furnace and machine, then back to the car, and eliminate the picking up process now so common in railroad shops. Fires should all be numbered—this to simplify distribution of work.

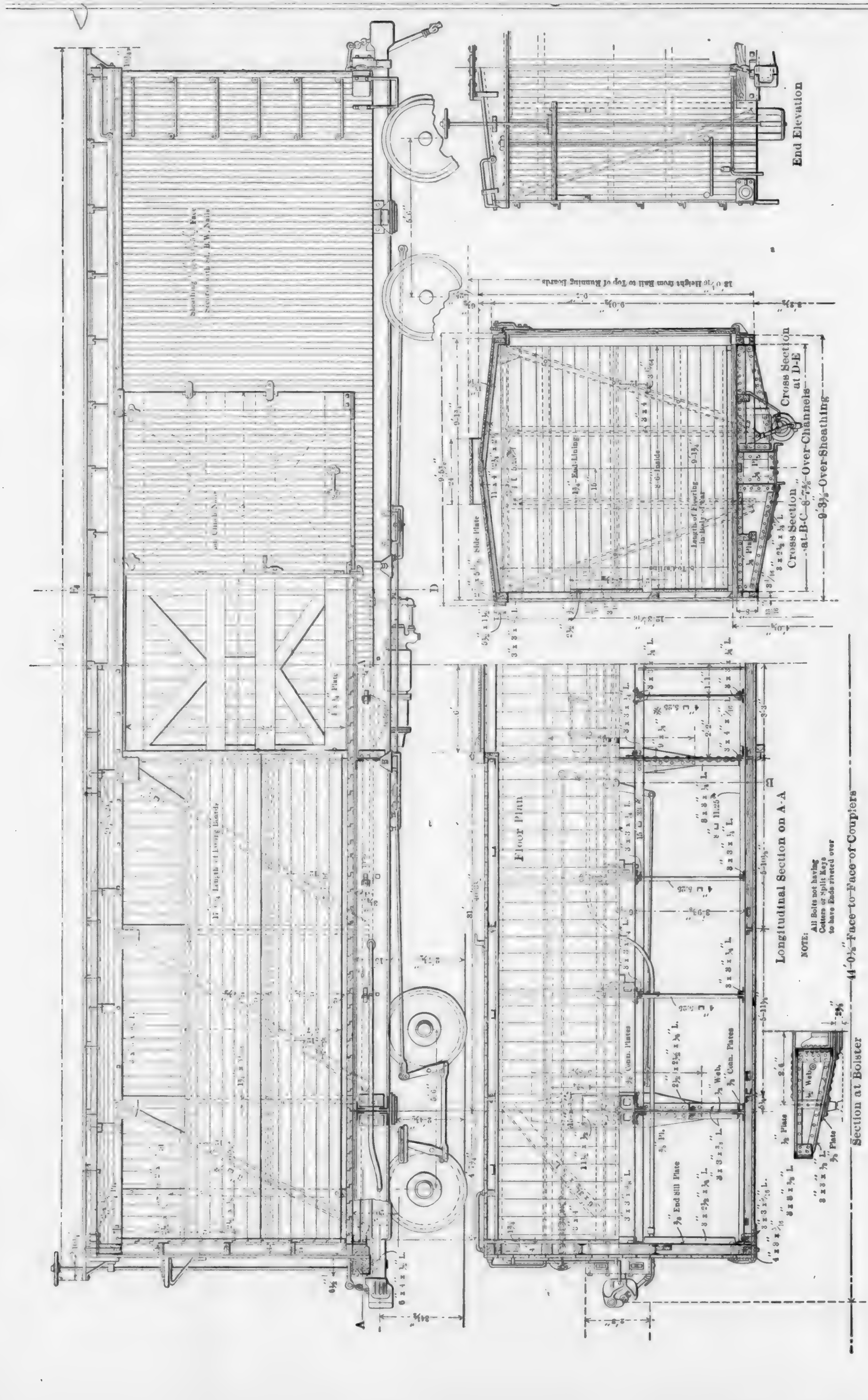
Meetings of all foremen should be held every two weeks, and all should be made to feel at liberty to express themselves. The superintendent of shops should spend a considerable part of his time in the shop and be very careful to demonstrate occasionally—this in order to show that he understands his business. In these days nothing will command respect quicker than confidence in the ability of the leader. In addition he must be fair, upright and cheerful. Cheerfulness is contagious, and spreads with great rapidity, and it inspires confidence.

In the past much attention has been given to shop design and, unfortunately, very little to shop organization. No matter how well a shop is designed and equipped, the efficiency of the plant will depend solely upon the man in charge of operations.

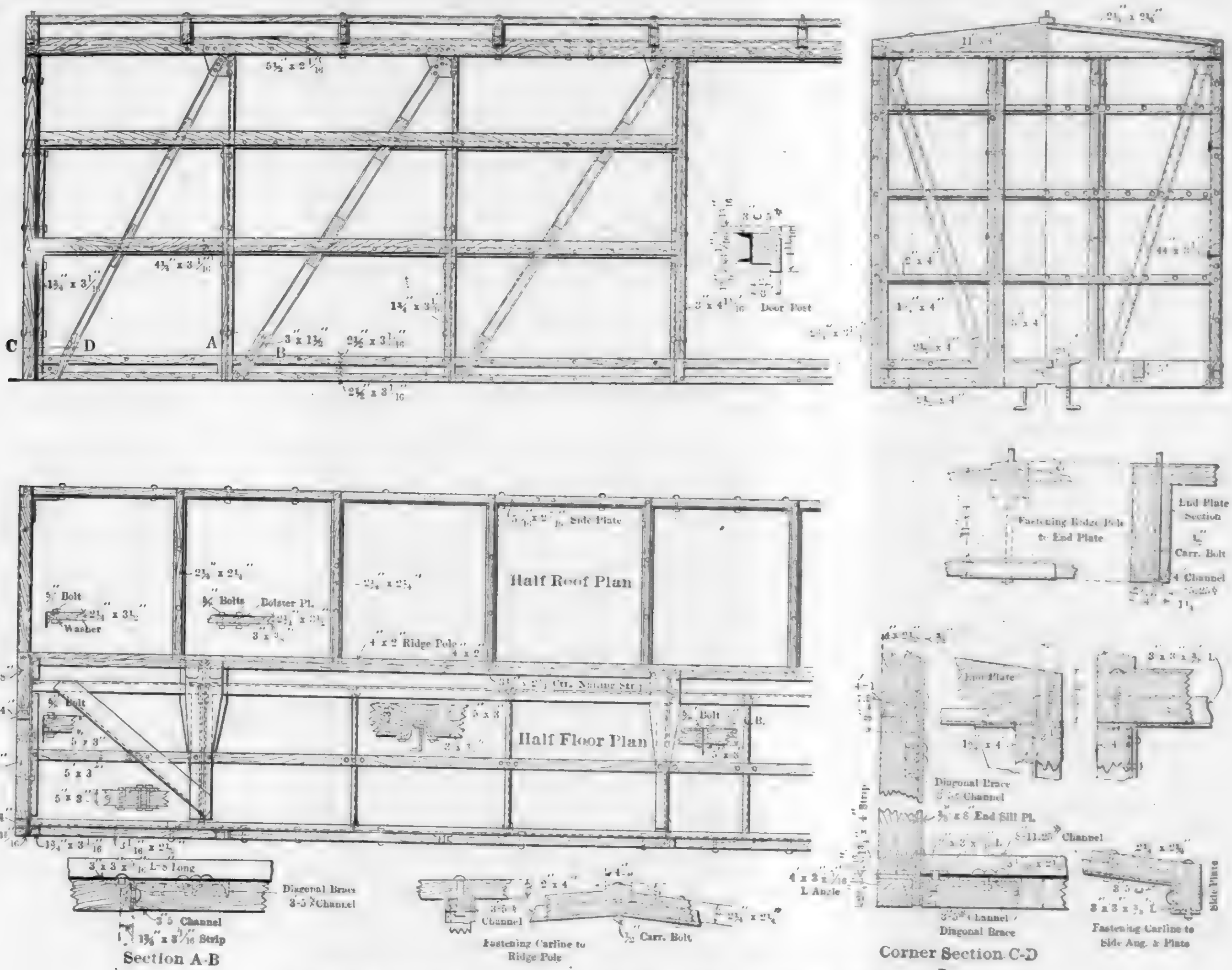
LOCOMOTIVE VS. STATIONARY PLANT.—The locomotive is ordinarily considered a crude and wasteful type of heat engine, unsusceptible, by reason of the rugged character of its service, of the refinements of its stationary and marine contemporaries; a machine highly developed if you will, for a special purpose, but in which efficiency as a heat engine has been sacrificed to the necessities of its nomadic and strenuous existence. This popular idea of the locomotive will be rudely shaken by the volume before us, which declares that "It is a fact of more than ordinary significance that a steam locomotive is capable of delivering a horse power at the draw-bar upon a consumption of but a trifle more than 2 lbs. of coal per hour." This certainly is "of more than ordinary significance" when it is considered that this is not only brake-horse-power, but that it involves the efficiency of a "boiler on wheels" evaporating three or four times as much water per unit of surface as a stationary boiler does.—*Book review of "Locomotive Tests and Exhibits, P. R. R.," in* POWER.

ENGINE HOUSE CONDITIONS.—To get the best service from the men doing this work it is very necessary for the foreman to see that the engine house or terminal is kept clean and neat as conditions will permit. The pits should be kept clean and free of water, dirt, rubbish and scrap material, as actual working conditions will permit. The floor should be kept clean, and all scrap material removed from engines taken away as soon as possible, to permit the men employed in inspecting and making repairs to have ample room and good facilities to carry on their work under the best conditions possible. Good lighting facilities should be provided, so that the men can see to do their work properly when working at night or at any time or place where artificial light is required.—*Mr. E. T. James, New York Railroad Club.*

CASUALTIES ON ENGLISH RAILWAYS.—The number of persons killed and injured on the railways of the United Kingdom during the year ended December 31st last were as follows: Killed, 1,100; injured, 6,460. By accidents to trains and rolling stock the number of persons killed was 39 and injured 396.—*Engineering* (London).



STANDARD 40-TON BOX CAR—ROCK ISLAND SYSTEM.



FRAMING DETAILS, STANDARD BOX CAR.—ROCK ISLAND SYSTEM.

40-TON STANDARD BOX CAR.

ROCK ISLAND SYSTEM.

The illustrations show a design of steel-frame box car recently adopted as a standard by the Rock Island and 'Frisco Lines. It is not a common standard throughout, as the two lines differ somewhat in regard to details and specialties.

The upper and lower framing is of steel similar to the Norfolk & Western composite construction, but, owing to the fact that this car is 40 ft. long inside, several modifications were introduced that may be of interest. In order to shorten the sills, the end posts and braces are attached outside of the end sill, thus economizing to the extent of about 9 ins. in the length of the main members. The side girths, of steel, are continuous from the door posts to the corners and are backed with sectional wood filling blocks. It has become a very serious problem to effectually hold the ends of wooden cars against the shocks of switching and shifting loads and these girths being attached to all side members make a very strong tie for this purpose. The design presents a very strong end with I beam intermediate posts and angle corner posts, all tied with girths and with end lining 1¾ ins. thick.

The flooring is brought down onto the top flanges of all sills and is nailed at five points. The carlines are of steel, supporting longitudinal roof boards which carry an outside steel roof. One special point in the framing is the introduction of cross bearers at the door posts to assist and strengthen the center sills, utilizing the excess of strength in the side framing. The construction of the bolsters and cross bearers, which are built up of plates and angles, is similar.

The objects sought in this design are simplicity and strength; moderate weight and utilization of standard sections and materials; stiffness of the structure to prevent weaving and movement that causes so much renailing in wooden cars; strength of end construction to eliminate a large class of repairs; to provide an under construction that will facilitate inspection and generally to provide a car that can be built, repaired and maintained with present railroad shop facilities.

The design was made in the office of Mr. C. A. Seley, mechanical engineer of the Rock Island at Chicago.

TURNING STEEL-TIRED CAR WHEELS.—The capacity of our Pond steel-tired car-wheel lathe has increased so much in the last two years, due to various improvements in the lathe and in the method of handling the work, that the former methods which we recommended no longer hold good. At the present time many of these lathes are getting out a pair of wheels an hour. We have a record of 518 pairs finished in 447 consecutive working hours. In another shop 14 pairs of wheels were finished in 10 hours. The amount the tires are worn makes very little difference in the output of the lathe, as the tread is roughed out at one cut, even though the depth of cut may be ½ to 9/16 in.—*Progress Reporter for June.*

HIGH TEMPERATURE IN GASOLINE ENGINES.—In the petrol-engine cylinder, the highest temperature reported is in the neighborhood of 4,000 deg. F. This is at the hottest portion of the exploding mixture of gas and air.—*The Engineer.*

(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE.

J. S. BONSALL,
Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT, } Editors.
E. A. AVERILL, }

JUNE, 1906.

Subscription.—$2.00 *a year for the United States and Canada;* $2.50 *a year to Foreign Countries embraced in the Universal Postal Union.*
Remit by Express Money Order, Draft or Post Office Order.
Subscription for this paper will be received and copies kept for sale by the
Post Office News Co., 217 Dearborn St., Chicago, Ill.
Damrell & Upham, 283 Washington St., Boston, Mass.
Philip Roeder, 307 North Fourth St., St. Louis, Mo.
R. S. Davis & Co., 346 Fifth Ave., Pittsburgh, Pa.
Century News Co., 6 Third St., S. Minneapolis, Minn.
W. Dawson & Sons, Ltd., Cannon St., Bream's Buildings, London, E. C., England.

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It is very pleasant to have readers express appreciation for the good things we may do, and it spurs us on to greater efforts, but it is far more valuable to have them frankly criticise things that are not so well done. The editors of this journal invite suggestions and frank criticisms concerning the work of the editorial department. What can we do to make our pages of more value to you?

The fact that the wages of every shop foreman on a large system were recently increased is significant. With the introduction of piece-work it was no unusual thing to have piece-workers receiving a larger check at the end of the month than some of the foremen. The piece-worker by mere physical ability, with possibly a little careful thought, was receiving as much or more than those men who were doing the planning, making the improvements and carrying on the organization. The effect of the encouragement which this act of the railroad gave to the foremen cannot be overlooked. and it is to be hoped that other roads will follow the example.

It is interesting to note the changes made in two of the locomotives illustrated in this number, both of which are redesigns of classes which have been in successful operation for several years. It is noticeable first that the size and power has not been changed in either case, indicating that they are sufficiently large for the service demanded; and secondly that the Walschaert type of valve gear has been applied where the Stephenson was used before. This move has particular signficance in the case of the Lake Shore engine since this road has had the longest experience with the Walschaert gear of any in this country, and it would indicate that the gear had proved itself to have the advantages claimed for it. The application of piston valves to the Pennsylvania freight engine, where slide valves had been previously used is also worthy of notice. There has been practically no change in the boilers which apparently have proven to be satisfactory both from a capacity and maintenance standpoint.

In a valuable paper on the "Care and Maintenance of Locomotives at Terminals to give Maximum Mileage and Efficient Service" read before the New York Railroad Club by Mr. E. T. James, the following specifications were presented for a succesful roundhouse foreman. "The foreman of this highly important department should be a good, bright, energetic, trustworthy and thoroughly competent man, having had experience in repairing and caring for engines, so that he will have the required experience and judgment to decide what must be done at once, and instruct his men the proper way to do it. At times it will be necessary for him to quickly decide questions pertaining to work and in such a way that the best results will be obtained for the service. He should have the confidence of his men, should know their qualifications thoroughly, and arrange to assign the work in such a way that the men are given the work they are best adapted to perform." In the discussion which followed the reading of the paper, it was quite generally admitted that while a man who could fill these specifications would make a splendid roundhouse foreman, yet the compensation usually offered for this position was not sufficient to attract and hold such a man. This sentiment was very nicely summed up in the following incident, which was related by one of the club members at the close of the discussion. A bright young man had worked his way up to the position of roundhouse foreman and filled it with satisfaction to all concerned. He resigned to accept a place with a supply concern. Not an engineer running regularly on the division could be found who could afford to take his place and as a last resort it was offered to an engineer running a construction train. The shame lies not so much in the fact that the incident related is a true one as that it reflects a condition at present existing on a large number of railroads.

A TABULAR COMPARISON OF NOTABLE

ARRANGED WITH RESPECT

PASSENGER LOCOMOTIVES.

Type—Drivers / Type—Name	4-6-2 (PACIFIC).										2-6-2 (PRAIRIE).		
Name of railroad	O. R. & N.	Erie R.R.	A.T.&S.F.	Har'm'n Lines.	C. & A.	M.C.R.R.	So. Ry.	N. P.	N. Y. C. & H. R.	C. R. I. & P.	Pa. R.R.	L. S. & M. S.	C.B.&Q.
Road No. or class	194	2511	1251	P-141	602	K-80	1238	Q-1	K	841	2761	J-41	1950
Builder	Bald.	Amer.	Bald.	Bald.	Bald.	Amer.	Bald.	Amer.	Amer.	Amer.	Amer.	Amer.	Amer.
Simple or compound	Balance Comp.	S.-Heat. Simple	Balance Comp.	Simple.	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple
When built	1905	1905	1905	1905	1904	1904	1906	1904	1903	1905	1905	1904	1905
Tractive effort	28,300	30,000	32,800	29,920	29,900	28,500	34,940	31,000	28,500	31,000	27,520	27,800	35,050
Weight, total lbs.	231,300	230,500	226,700	222,000	221,500	221,000	219,500	219,000	215,000	212,000	234,500	233,000	210,000
Weight on drivers	143,600	149,000	151,900	141,000	135,110	140,500	138,460	142,500	141,000	143,500	166,800	165,200	151,000
Weight on leading truck	43,400	41,000	35,800	37,000	40,500	42,500	39,740	39,000	36,000	34,500	27,000	26,000	22,000
Weight on trailing truck	44,300	40,500	39.000	44,000	45,490	38,000	41,300	37,500	38,000	34,000	40,700	41,800	37,000
Weight of tender loaded	159,000	163,000	.....	162,200	166,600	122,600	136,800	128,600	127,000	150,000	143.000	159,900	148,200
Whl. base, driving, ft. & ins.	13-4	13-0	13-8	13-4	13-4	13-0	12-6	12-0	13-0	12-4	14-10	14-0	13-4½
Whl. base, engine, ft. & ins.	33-7	33-8	34	33-4	33-4	33-7½	31-4½	32-6	33-7½	32-0	34-3	34-3	30-8½
Whl. base, engine and tender	64-1½	65-1	66-1½	63-10½	62-5½	60-5	64-5⅞	62-0½	59	61-1	64-10¼	62-4⅜	62-2¾
Driving wheels, diam., ins.	77	74	73	77	77	75	72½	69	75	69	50	79	69
Cylinders, number	4	2	4	2	2	2	2	2	2	2	2	2	2
Cylinders, diameter, ins.	17&28	22-⅛	17&28	22	22	22	22	22	22	22	21½	21½	22
Cylinders, stroke, ins.	28	26	28	28	28	26	28	26	26	26	28	28	28
Heat. sur., firebox, sq. ft.	179	195	192.8	174	179	180.3	195	179.4	178.65	179.41	198	222	230
Heat. sur., arch tubes., sq. ft.	....	....	....	....	....	26.8	....	9	27.35	....	......	......	......
Heat. sur., tubes, sq. ft.	2,874	3,131	3,402.2	2,874	2,874	3,690.6	3,683.5	3,361	3570	3,174.5	3,677.9	3679	3,353.4
Heat. sur., total, sq. ft.	3,055	3,326	3,595	3,048	3,053	3,897.7	3,878.5	3,549.4	3,776	3,353.92	3,976	3901	3,583.4
Firebox, length, ins.	108	108⅛	108	108	108	96⅛	108⅛	96	96⅛	96 1-16	108⅛	108⅛	108⅛
Firebox, width, ins.	66	75¼	71¼	66	66	75¼	72¼	65¼	75¼	67¼	73¼	73¼	72¼
Grate area, sq. ft.	49.5	56.5	53	49.5	49.5	50.23	54.25	43.5	50.23	44.8	55	55	54.25
Boiler, smallest diam., ins.	70	74⅝	70	70	70	72-1/16	70	70⅝	70⅝	68⅜	73	70	70
Boiler, height center	....	113½	....	9-5	113	113	109	115	113	113½	9-8½	114	8-11⅜
Tubes, No. and diam. in ins.	245-2¼	195-2¼ 32-5	290-2¼	245-2½	245-2¼	354-2	314-2¼	374-2	303-2¼	328-2	322-2¼	322-2¼	301-2¼
Tubes, length, ft. and ins.	20-0	20-0	20-0	20-0	20-0	20-0	20-0	18-6	20-0	18-7	19-5	19-6	19-0
Steam pressure, lbs., per sq. in.	200	200	220	200	200	200	220	200	200	200	200	200	210
Type of boiler	Str.	Str.	W. T.	Str.	Str.	Str.	Str.	E.W.T.	Str.	E.W.T.	Str.	E.W.T.	Str.
Fuel	Bit.	Bit.	Oil	Oil or Coal	Bit.	Bit.	Bit.	Bit	Bit.	Bit.	Bit.	Bit.	Bit.
Tender, coal capacity, tons	10	16	3,300	12	15	10	12½	12	10	13	13½	15	13
Tender, water capacity, gals.	9,000	8,500	8,500	9,000	8,400	6,000	7,500	6,000	6,000	7,500	7,000	8,000	8,000
Reference in the American Engineer	1905, p. 246	1905, p. 172	1905, p. 454	1905, p. 154	1904, p. 133	1904, p. 347	1906, p. 145	1905, p. 8	1904, p. 87	1905, p. 282	1906, p. 73	1904, p. 413	1905, p. 78

FREIGHT LOCOMOTIVES.

Type—Drivers / Type—Name	0-6-6-0 Mallet	2-10-2 Santa Fe	2-10-0 (DECAPOD.)		2-8-2 (MIKADO).			2-8-0 (CONSOLIDATION.)					
Name of railroad	B. & O.	A. T. & S. F.	A. T. & S. F.	M.St.P. &S.S.M.	N. P.	A. T. & S. F.	N. P.	P.B.& L.E.	L. S. & M. S.	Lehigh Valley	N. Y. C. & H. R.	L. S. & M. S.	N. Y. C. & H. R.
Road No. or class	2400	900	987	600	W. (com.)	885	1554	150	G-46	1301-15	G-4	G-5	G-5 F.
Builder	Amer.	Bald.	Bald.	Bald.	Amer.	Bald.	Amer.	Pitts.	Amer.	Bald.	Amer.	Amer.	Amer.
Simple or compound	Comp.	Tan. Comp.	Tan. Comp.	Vauc. Comp.	Tan. Comp.	Vauc. Comp.	Simple	Simple	Simple	Vauc. Comp.	Tan. Comp.	Simple	Simple
When built	1904	1903	1902	1900	1905	1902	1905	1900	1903-4	1898-9	1903	1904	1905
Tractive effort	70,000	62,800	62,500	48,600	45,000	55,600	46,630	63,800	46,500	47,700	46,600	45,700	45,700
Weight, total lbs.	334,500	287,240	266,500	210,000	271,000	261,720	259.000	250,300	230,000	228,082	225,000	220,200	220,200
Weight on drivers	334,500	234,580	237,000	185,100	207,000	199,670	203,000	225,200	203,000	205,232	200,000	200,000	200,000
Weight on leading truck	....	23,420	29,500	24,900	30,300	27,250	25,400	25,100	27,000	22,850	25,000	20,200	20,200
Weight on trailing truck	....	29,240	....	....	33,700	34,800	30,600	....	....	....	....	....	....
Weight of tender loaded	143,000	158,500	132,000	124,550	148,500	136,000	148,500	141,000	148,000	148,000	137,500	140,000	141,600
Whl. base, driving, ft. & ins.	30-8	19-9	20-4	19-4	16-6	16-0	16-6	15-7	17-3	15-0	15-0	17-0	17-6
Whl. base, engine, ft. & ins.	30-8	35-11	29-10	28-0	34-9	31-6½	34-9	24-4	26-5	23-10	23-7	25-11	26-5
Whl. base, engine and tender	64-7	66-0	59-6	58-3	63-1	59-5½	63-1	57-11¾	57-9¾	57-10¼	59-1	60-7	60-6½
Driving wheels, diam., ins.	56	57	57	55	63	57	63	54	58	55½	51	63	63
Cylinders, number	4	4	4	4	4	4	2	2	2	4	4	2	2
Cylinders, diameter, ins.	20&32	19&32	19&32	17&28	19&30	18&30	24	24	23	18&30	16&30	23	23
Cylinders, stroke, ins.	32	32	32	32	30	32	30	32	30	30	30	32	32
Heat. sur., firebox, sq. ft.	220	209	210.3	191.96	200	210.3	200	241	232	193	201	220	185.64
Heat. sur., arch tubes, sq. ft.	....	....	23.9	....	9	....	9	....	....	....	26	....	27.41
Heat. sur., tubes, sq. ft.	5,380	4,587	5,155.8	2,808.04	3,819	5,155.8	3,819	3,564	3,725	3,952	3,915	3,717	3,512
Heat. sur., total, sq. ft.	5,600	4,796	5,390	3,000	4,028	5,366.1	4,028	3,805	3,957	4,145	4,142	3,937	3,702.52
Firebox, length, ins.	108⅛	108	108	132	96	108	96	132	108	120	105¼	105-1/16	108 1/16
Firebox, width, ins.	96¼	78	78	41	65¼	78	65¼	40¼	73¼	108	79⅜	75¼	75¼
Grate area, sq. ft.	72.2	58.5	58.5	37.5	43.5	58.5	43.5	36.8	55	90	58	54.9	56.47
Boiler, smallest diam., ins.	84	78¾	78.75	68	75¾	78¾	75¾	84	80	80	77	81⅝	80
Boiler, height center	10-0	9-10	9-10	107	118	9-10	118	119¾	119½	103⅜	111	114	117
Tubes, No. and diam. in ins.	436-2¼	391-2¼	463-2¼	344-2	374-2	463-2¼	374-2	406-2¼	461-2	502-2	507-2	458-2	446-2
Tubes, length, ft. and ins.	20-10¾	20-0	19-0	15-7	19-6	19-0	19-6	15-0	15-6⅛	15-0⅞	14-9	15-6	15-0½
Steam pressure, lbs., per sq. in.	235	225	210	215	200	225	200	220	200	200	200	200	200
Type of boiler	Str.	W. T.	W. T.	E.W.T.	E.W.T.	W. T.	E.W.T.	Str..	W. T.	Wooten	E.W.T.	Str.	Str.
Fuel	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Anth.	Bit.	Bit.	Bit.
Tender, coal capacity, tons	16	14	11	9	12	12	12	14	16	12	12	12	12
Tender, water capacity, gals.	7,000	8,500	7,000	7,000	8,000	7,000	8.000	7,500	7,500	7,500	7,000	7.500	7,500
Reference in the American Engineer	1904, p. 237&262	'03, pp.372 & 398 '04 p.176	1902, p. 192	1900, p. 319	1905, p. 367	1903, pp. 16&109	1905, p. 5	1900, p. 214	1903, pp. 416&439 '04,p.12	1898, p. 395	1903, p. 174	1905, p. 46	1905, p. 214

NOTE.—These figures have been verified by the railroad officials in charge.

EXAMPLES OF RECENT LOCOMOTIVES.

TO CLASSES AND WEIGHTS.

PASSENGER LOCOMOTIVES.

4-4-2 (ATLANTIC).											4-6-0 (TEN WHEEL).			4-4-0 (AMERICAN).	
Erie R.R.	N. Y. C. & H. R.	Erie R.R.	Pa. R. R.	Pa. R.R.	N. Y. C. & H. R.	C. B.&Q.	Harrim'n Lines.	C.R.I. & P.	C. R. I. & P.	Pa. R. R.	D.L.&W.	N. Y. C. & H. R.	D.&H. Co.	C. R. R. of N. J.	D.L.&W.
537	I	535	2760	2759	I-1	2700	A81	1048	1019	2512	1012	2099	502	852	955
Amer.	Bald.	Bald.	Amer.	Bald.	Amer.	Bald.	Bald.	Bald.	Amer.	Soc. Als.	Amer.	Amer.	Amer.	Amer.	Amer.
Balance Comp.	Balance Comp.	Balance Comp.	Balance Comp.	Balance Comp.	Balance Comp.	Balance Comp.	Simple	Balance Comp.	Simple S-Heat	DeGlehn Comp.	Simple	Simple	Simple	Simple	Simple
1905	1905	1905	1905	1905	1904	1904	1905	1905	1905	1904	1905	1905	1903	1905	1905
23,860	24,200	28,000	23,300	23,300	24,000	21,400	23,560	24,000	24,700	19,530	35,100	31,000	27,100	23,120	23,710
206,000	204,500	204,200	200,500	200,400	200,000	196,600	196,000	195,000	191,300	164,000	201,000	194,500	175,000	161,300	151,200
115,000	110,000	113,500	117,200	119,600	110,000	101,200	105,000	102,000	107,100	87,850	154,000	148,000	131,500	111,300	100,000
52,000	52,400	47,500	52,500	46,500	50,000	54,200	45,000	51,780	42,400	41,250	47,000	46,500	43,500	50,000	51,200
39,000	42,100	41,200	30,000	34,300	40,000	41,200	46,000	42,080	40,800	34,900	....	....	....	....	....
162,800	124,000	155,000	132,500	132,500	124,000	120,400	162,200	144,000	144,000	132,500	120,000	143,500	120,166	122,200	110,000
7-0	7-0	7-0	7-5	7-5	7-0	7-3	7-0	6-10	7-0	7-0½	14-4	15-10	15-0	8-3	8-6
28-9	30-9	30-1	31-11	33-8	27-9	30-2	27-7	30-3	27-5½	28-6 9/16	25-6	26-10½	26-4	23-1½	24-5
60-9	56-8	59-10½	61-4 1/16	63-1 1/16	53-8	57-6¾	58-2	....	57-2	59-5	54-0¼	59-2	53-7½	49-2	51-0⅝
78	79	72	80	80	79	78	81	73	73	80 5/16	69	69	72	69	69
4	4	4	4	4	4	4	2	4	2	4	2	2	2	2	2
15½&26	15½&26	16 & 27	16 & 27	16 & 27	15½&26	15 & 25	20	15&25	21	14 3/16 & 23⅝	22½	22	21	19	20
26	26	26	26	26	26	26	28	26	26	25 3/16	26	26	26	26	26
181.1	175	181	181.4	166	175	155.5	174	194	161.8	181.1	221.7	180.3	179.68	167.6	190.8
......	23		......	......	23	......	......	......	......	......	......	22.7	78.54	......	
3,453.6	3,465	3,458	2,680	2,698	3,267	3,050.5	2,475	3,048	2,227.56	2,435.7	3,156.3	3,124	2,405.5	1,838.1	1,947.89
3,634.7	3,663	3,639	2,861.6	2,864	3,465	3,206	2,649	3,242	2,389.36	2,616.8	3,378.0	3,327	2,663.72	2,005.7	2,138.69
108⅛	96⅛	108⅛	111	111	96⅛	96⅛	108	107 1/16	96 1/16	119⅞	126⅛	105⅛	119⅞	122⅛	126 3/16
75¼	75¼	72	72	72	75¼	66¼	66	67¼	67¼	40	108¼	75¼	102	96¼	100
56.5	50.3	54	55.5	55.5	50.23	44.14	49.5	50.2	44.8	33.9	94.8	54.93	84.85	81.6	87.54
70¾	70⅝	68	65⅝	65⅝	70⅝	64	70	66	72	59⅝	74⅝	70⅝	66¼	62¼	61 3/16
111⅝	9-3	9-2	9-1	9-1	11-1/16	9-⅛	9-5	107	108	8-10 5/16	116½	9-7	113	113	
388-2	318-2¼	309-2¼	315-2	261-2¼	390-2	264-2¼	297-2	273-2¼	173-2 54-3½	139 2 13/16	398-2	400-2	308-2	280-2	280-2
17-0	18-6	19-0	16-3	17-7	16-0	19-0	16-0	18-10	16-0	14-5¼	15-3	14-11	15	12-6	13-4¼
220	220	225	205	205	220	210	200	220	185	227½	215	200	200	200	185
E. W. T.	Str.	W. T.	Belpaire	Belpaire	Str.	W. T.	Str.	W. T.	Str.	Belpaire	Str.	W. T.		W. T.	Str.
Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Coal or Oil	Bit.	Bit.	Bit.	Anth.	Bit.	Culm.	Anth.	Anth.
16	10	12	12½	12½	10	12	10	12	12	12½	10	12	12	12	10
8,500	6,000	8,500	5,500	5,500	6,000	6,000	9,000	7,000	7,000	5,500	6,000	7,000	6,800	5,000	5,000
1905 p.	1905, p.	1905, p.	1906, p.	1906, p.	1904, p.	1904, p.	1905, p.	1905, p.	1905, p.	1904, p.	1905, p.	1906, p.	1903, p.		
287	109	177	73	73	166	212	154	416	329	203	407	59	285		

FREIGHT LOCOMOTIVES.

2-8-0 (CONSOLIDATION).								4-6-0 (TEN WHEEL).			0-10-0	0-8-0	0-6-0 (SWITCHER).		
Pa. R.R.	A. T. & S. F.	N. P.	B. & O.	Har'm'n Lines.	"Soo Line."	N. Y. C. & H. R.	C. P. R.	C. P. R.	C.&E.I.	C. R. I. & P.	L. S. & M. S.	C. & O.	P. R. R.	Har'm'n Line.	C. R. I. & P.
2762	824	....	2503	C-187	445	G-2	1621	1300	289	1554	M.	8	B-6	S-150	114
Amer.	Bald.	Amer.	Amer.	Bald.	Amer.	Schen.	Amer.	Amer.	Bald.	Bald.	Amer.	Amer.	P. R. R.	Bald	Amer.
Simple	Vauc. Comp.	Tan. Comp.	Simple	Simple	S.-Heat. Comp.	2-cyl. Comp.	S.-Heat. Simple	S.-Heat. Comp.	Bal. Comp.	Simple	Simple	Simple	Simple	Simple	Simple
1905	1902	1901	1905	1905	1905	1901	1904	1903	1905	1905	1905	1903	1904	1905	1905
45,700	45,300	44,900	41,100	43,29[illegible]	37,300	39,300	36,800	31,200	31,000	34,000	55,300	41	36,100	27,915	31,300
220,000	214,600	209,500	208,500	208,000	201,500	192,000	186,525	192,020	191,060	173,720	270,000	171,175	170,000	150,000	138,500
198,000	191,400	185,500	185,900	187,000	174,000	166,000	164,000	141,095	145,260	131,200	270,000	171,175	170,000	150,000	138,500
22,000	23,200	24,000	22,600	21,000	27,500	26,000	22,525	50,925	45,800	42,520	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
140,500	110,000	....	143,500	135,050	116,900	114,000	125,700	122,000	120,000	144,000	....	121,160	132,500	85,100	41,600
17-6	15-4	15-0	16-8	15-8	17-0	17-0	15-10	14-10	13-6	15-0	19-0	13-7½	11-6	11-4	11-0
26-5	24-6	23-8	25-7	24-4	25-11	25-11	24-4⅛	26-1	27-7	26-6	19-0	13-7½	11-6	11-4	11-0
60-3¾	54-2¾	52-4½	59-8¼	55-11¾	55-8¼	53-11	53-4¼	54-6	55-8	56-5½	54-5½	45-8	46-8¼	42-9	41-10
63	57	55	60	57	63	63	57	62	62	63	52	51	56	57	51
2	4	4	2	2	2	2	2	2	4	2	2	2	2	2	2
23	17&28	15&28	22	22	23&35	23&35	21	22&35	15½&26	22	24	21	22	20	19
32	32	34	30	30	34	34	28	30	26	26	28	28	24	26	26
182	235	173	179.3	177	158	155.4	166	180	160.7	160.8	197	164	152.1	150	100
....	....	22.9	....	....	....	27.1	340	290	....	....	....	....	....	....	....
3,600	4,031	3,450.4	2,630.1	3,226	2,407.5	3,298.1	2,493.7	3,312.6	2,933.7	2,426	4,422.6	2,573	2,343	1,650	1,862
3,782	4,266	3,646.3	2,809.4	3,403	2,565.5	3,480.6	2,659.7	2,492.6	3,094.4	2,586.8	4,619.6	2,737	2,495.1	1,800	1,962
106 1/16	84	100 1/16	107⅝	108	96⅛	96⅛	96⅝	102⅛	101⅞	96¼	108⅛	50	90	108	60
75¼	3-28 dia.	75¼	75¼	66	70¼	75⅝	65¼	70¼	66	67¼	73¼	70	65	40¼	68
55.4	......	52.3	56.24	49.5	46.8	50.3	43.8	49.82	46.69	44.9	55.4	38.8	41.25	30.2	28
80	74	75	74.5	80	67⅝	70⅝	70⅝	70½	64	68	80 1/16	67	67¼	70	62⅛
9-9	9-2	111¼	118	9-6	115	115	111½	111½	109	112	115	112½	....	8-7	....
446-2	652-1¾	442-2	282-2¼	413-2	224-2 40-3½	396-2	55-3 255-2	248-2 22-5	278-2¼	329-2	447-2	351-2	325-2	276-2	237-2
15-4¾	13-7	15-0	15-10	15	15-9	16-0	14-2½	14-7	18-0	14-2	19-0	14-0	13-10¼	11-6	15-0
200	210	200	205	200	210	210	200	200	225	185	210	200	205	180	200
Str.	E.W.T.	E.W.T.	Str.	Str.	E.W.T.	Str.	W. T.	W. T.	W. T.	W. T.	W. T.	W. T.	Belpaire	Str.	Str.
Bit.	Oil	Bit.	Bit	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.	Bit.
13½	2,200	10	15	14	10	10	12	10	12	12	12	7	11	6	6½
7,000	6,000	5,500	7,000	7,000	6,000	5,000	5,000	5,000	6,000	7,000	8,000	6,000	5,500	4,000	5,000
1906, p.	1902, p.		1906, p.	1905, p.	1905, p	1901, p.	1904, p.	1903, p.	1905, p.	1905, p.	1905, p.	1904, p.	1904, p.	1905, p.	1905, p.
73	10		31	154	150	53	454	317	97	362	330	184	384	154	443

The value of forging and bulldozing machines in increasing the efficiency and output of the smith shop is being very generally recognized by the railroad shop managements. These machines are, of course, of very little worth unless they are properly equipped with the dies and special devices for doing the work. The results which may be obtained by having a capable die maker placed in charge of this work are wonderful. In one large shop, where this was done, the first year showed an increase in tonnage of the forgings manufactured of 300 per cent. over the preceding year with the same machines and the same force of men at work, and at least 75 per cent. of this was due entirely to the development of special tools and dies for use with the forging machines and bulldozers.

"I don't want any more men fresh from college in my drawing room, they have got to be tried out a little and worked down to bed rock before I will waste time on any more of them." Thus writes a mechanical engineer of a prominent railroad. Investigation showed that except for the chief draftsman and a leading draftsmen he had weeded out practically all of the college men in the drafting room, and substituted in their place practical men who had taken a correspondence school course. His reasons were that the greater number of college men just from school, or even with more or less experience in the shops do not seem to have much of an idea as to how to apply their theoretical knowledge. They cannot be intrusted with important work and must be very closely watched and directed; as soon as they get to a point where they are of some value they become too big for the job and are anxious to get a better paying position.

The correspondence school man with some shop experience is even more helpless at the outset, but while he may never become as valuable as the college graduate he is quick to learn, and after he has got a good start is content to remain where he is until he has earned his promotion. His ideas as to compensation are much more reasonable than those of the college graduate, and, if there is a fair chance of promotion he is willing to work hard for it, and on the whole, is much more contented than the college graduate under similar circumstances. It is very poor policy to constantly keep changing the personnel of a drafting room force. When once a man becomes acquainted with the office methods and records he becomes a valuable asset, and it would appear to be good policy to select and train men who would stay in the office long enough to pay for the trouble and expense of "breaking them in."

The railroads do not have facilities for building steel cars, and this, in addition to the fact that these cars are practically blanketed with patents, and that in many cases the builders have special facilities for using certain shapes of material or types of construction, has possibly led many of the railroads, ordering steel cars, to leave the question of design to a too great extent in the hands of the engineering department of the car builder. Unless the mechanical department of each railroad very carefully checks the builder's designs various features creep in which are a source of annoyance and expense until they are remedied. It is to be regretted that in many cases the builders seem to forget that the cars ever have to be repaired, or that the railroad company is not as well equipped with special devices for doing the work as are the car builders. Again it quite often happens that a device or construction which may appear to be theoretically correct works out all wrong in practice. The car department spends its entire time in repairing and keeping the cars in running condition, and surely the experience thus gained should be used to check the work of the car designer, who is often a man skilled in the theory of mechanics, but with no practical experience in car work. Conditions in the operation of trains and the size and power of locomotives are constantly changing, and the effect of these upon the cars very soon become apparent to the officials of the car department, and this knowledge should be used in connection with the ordering of new cars. Each road also has peculiar conditions to contend with, and it is not to be expected that the car company's engineers can keep in close touch with these. The above is not intended as a criticism of the car designer, but rather to draw the attention of the railroads to the importance of carefully checking all designs for new equipment.

That the railroads are at last waking up to the importance of systematically and carefully looking after the shop apprentices is apparent. In some instances instruction is being given in mechanical drawing and mathematics, attendance at the classes being compulsory. In other cases the work of the apprentices is being more carefully supervised. One large system has even gone so far as to make a liberal appropriation for improving the condition of the apprentices and giving them the opportunity of bettering themselves, and thus becoming more valuable to the company. It was just a year ago that Mr. Basford presented his valuable paper on "The Technical Education of Railway Employees" before the Master Mechanics' Association, and, doubtless it has had much to do with the impetus which this movement seems to have gained during the year.

In one large shop where special efforts were made to supervise the work of the boys the results have been very gratifying. This shop has about thirty machine apprentices and a good mechanic has been placed in charge of them and devotes his entire time to instructing and coaching them in their work. The result of this improvement immediately became apparent in the better grade of work and the increased quantity turned out by the apprentices. The workmen look with considerable favor on the change and do all they can to make it a success. They are glad to see the boys taking advantage of an opportunity they never had, and which they realize would have improved their condition and increased their opportunities for advancement. A result which was not looked for, but which is important, was that the man first placed in charge of the boys developed so rapidly in executive ability that he was promoted and given a foremanship. Great care should be taken in selecting a man for this position. He must be one who can sympathize with the boys and look at things from their point of view; he must possess more than the usual amount of tact and push, and must be able to interest them in their work. Even if the railroads look at the question from the standpoint of immediate returns they will be amply repaid for installing a system such as the one just described, especially if classes in mechanical drawing and mathematics are carried on in connection with it.

The three most notable innovations applied to American locomotives during the past few years are the arrangement of cylinders on the balanced principle, the use of superheated steam and the Walschaert type of valve gear. The first of these thus far in this country has only been used on compound locomotives where, because of the different size of the two cylinders on the same side of the engine, it is not possible to attain exact balance. However, even under these circumstances most favorable reports have been given from the operation of this type, both in regard to its smoother riding and operation, as well as the better distribution of its power, and it seems safe to say that the balanced principle for high speed locomotives is an entire success, and, that it will undoubtedly be extended and become general for this type of power. The second of these new features, that of superheating, while not having been quite so widely tried in this country as the balanced principle, has nevertheless been reported to be an entire success with the proper design of superheater. Its chief value lies in the reduction of condensation in the cylinders, the more rapid and freer movement of superheated steam through the passages and the fact that superheated steam is a very poor conductor of heat, all of which tend

to allow a larger proportion of the heat in the steam to be transformed into useful work. The Walschaert valve gear has made a most favorable impression in this country for both fast and slow locomotives and has undoubtedly come to stay.

So far as we know these three devices or principles have not all been applied to any single locomotive in this country, but we illustrate elsewhere in this issue a locomotive built for the Belgium State Railways, which incorporates all three of them and makes further improvement in obtaining exact balance by the use of four equal cylinders, all connected to the same pair of drivers. These four cylinders are each operated on the simple principle and have their valves so inter-connected that each will give exactly the same power; thus presenting ideal conditions of balance.

The use of four simple cylinders with four separate valves, a duplication of passages and a general complication of the cylinder castings and connections would seem to present a number of disadvantages from the standpoint of steam economy, which in themselves might be great enough to overcome the advantage to be obtained by the perfect balance of the reciprocating parts. However, the use of superheated steam gives conditions which nullify to a large extent these disadvantages, and prevents the larger surfaces of cylinders and passages from giving the trouble with condensation they would be expected to give with saturated steam. The possibilities of this combination are attractive and should receive the serious consideration of motive power men, who are looking for further improvement in our high speed locomotives

AMERICAN ENGINEER TESTS ON LOCOMOTIVE DRAFT APPLIANCES.

An elaborate series of tests on locomotive draft appliances were made in 1894 in Hanover, Germany, by Messrs. Von Borries and Troske (American Engineer and Railroad Journal, 1896). The Master Mechanics' committee on Exhaust Nozzles and Steam Passages presented excellent reports on these subjects in 1894 and 1896, the tests being made on an actual locomotive on a testing plant. In the American Engineer and Railroad Journal, June, 1900, Mr. H. H. Vaughan presented an article in which the need of further and more exhaustive tests on front-end arrangements was discussed. In 1901 the American Engineer and Railroad Journal conducted an extensive series of tests on locomotive draft appliances at Purdue University, the results of which were presented in this journal during the years 1901, 1902 and 1903. At the 1902 Master Mechanics' convention a committee was appointed to assist the American Engineer and Railroad Journal in carrying out these tests. At the 1905 meeting of the Association the committee reported that liberal contributions had been received from over 70 railroads and from the two leading locomotive companies for carrying the tests to completion. A recommendation was made by the committee, and adopted by the Association, that the results of these tests should be published in the American Engineer and Railroad Journal when they were concluded. The committee has just completed its work and presents the following report. An appendix, which accompanies the report, gives a more elaborate presentation of methods and results:

REPORT OF COMMITTEE ON LOCOMOTIVE FRONT-ENDS.

To the President and Members of the Master Mechanics' Association:

The undersigned, your committee, appointed to "assist in the tests being conducted at Purdue University, Lafayette, Ind., by the American Engineer and Railroad Journal, and to carry on the tests outlined in its report to the convention in 1903," respectfully submit the following:

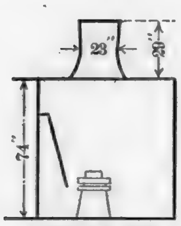
Historic Statement.—The Association as early as 1890 had appointed a committee to report on the best forms of exhaust-nozzles and steam-passages. This committee, after making one report, and after being continued for several years, finally gave way to a new committee under the chairmanship of Mr. Robert Quayle, with the result that in 1896 an epoch-making report was presented. The work of this committee settled two important questions, viz., the action of the exhaust-jet and the form and proportions of the exhaust-pipes and nozzles.

In 1901 the American Engineer and Railroad Journal became the patron of Purdue University for the purpose of advancing an experimental study embracing the form and proportion of locomotive stacks, and invited and secured as an advisory committee the assistance of distinguished motive power officials. By virtue of this arrangement an elaborate investigation was planned and completed, with results which were expressed in the form of general equations, by the use of which it was assumed that the stack for any engine might be correctly proportioned. The results of this investigation appeared in the columns of the American Engineer and Railroad Journal during the following year. These experiments, however, were made upon an engine having a diameter of boiler of but 52 ins., which is far less than that of the modern locomotive, and they were chiefly concerned with the problem of the outside stack. In consequence of these facts there was a common desire to have the experiments repeated upon a locomotive of large size, and to have the study extended to include the draft-pipe problem, the effect of inside stacks and of false tops in the smoke arch. In response to this feeling the Association in June, 1902, laid the foundation for the work which finds its completion in the present report. It was at this time that your committee was appointed. A year later the committee made a report, giving a summary of the work already accomplished, and presenting an outline of such additional work as was most needed. It reported that Purdue was ready to proceed with the work, that the New York Central Railway Company was prepared to loan an engine of large size for the use of the committee, and they submitted an estimate of the cost of the experiments they proposed. This report was received, and the committee continued for another year, since which time it has each year made a report of progress and has been continued. New York Central Atlantic type locomotive No. 3929 was delivered to the University Laboratory in November, 1905, and continued to occupy the testing laboratory until the following April. During this interval there were obtained the results herein described.

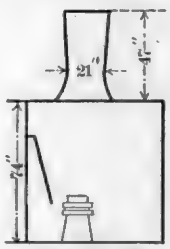
Co-operating Influences.—First among those to whom acknowledgment is due is the American Engineer and Railroad Journal, by whose enterprise the original investigation was outlined and by whose efforts substantial progress in its development was achieved. While its formal contribution has long since been submitted, its interest has not failed, and your committee acknowledge with pleasure the assistance which from time to time has been rendered by representatives of this journal. The Standard Oil Company has presented your committee with one of the several carloads of fuel oil needed. Seventy-four railway companies made contributions of money to meet necessary expenses. The New York Central lines have contributed, without charge, the use of a locomotive for a period of 5 months; they have delivered the locomotive to the University laboratory, and received it back again from the laboratory, without expense to your committee. They have also made the necessary experimental stacks and draft-pipes from drawings supplied by your committee and fitted the same to the engine upon which they were to be used. Purdue University has contributed the use of its laboratory and the time of its expert staff, the costs to your committee having been only such as have arisen from the supplies consumed and the time of necessary extra attendants. The tests have been under the direct supervision of Professor W. O. Teague, Assistant Professor of Experimental Engineering, whose report, which accompanies, covers all details of the tests. It is the understanding of your committee also that Professor Teague has been enthusiastically assisted by Mr. L. E. Endsley, Instructor in Engineering Laboratory in charge of the locomotive testing plant. To all of these, as well as to others, too numerous to mention, your

committee respectfully acknowledges its indebtedness and returns its thanks.

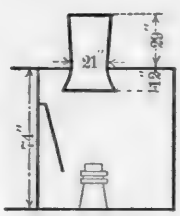
Outside Stacks.—The tests of outside stacks involved two different heights, namely, 29 and 47 ins. The 29-in. height only is practicable for road conditions upon the locomotive under test. Stacks of each of these heights were supplied in diameters ranging from 15 to 21 ins. by 2-in. steps, and as the work proceeded it seemed desirable to extend the range with the result that, in the 29-in. height, stacks of 23 and 25-in. diameter respectively were added to the series. In these tests no draft-pipes nor nettings were employed in the front-end; the diaphragm and exhaust-pipe were the only details present. Under these conditions, with a 29-in. height, the best diameter was found to be 23 ins., though this was not much better than that of 21 ins. With a 47-in. height the best diameter is 21 ins. The exact arrangement of equipment for the best results is shown by Figs. 1 and 2. The notation under these figures and under those which immediately follow gives the draft obtained with a constant back pressure of 3.5 lbs. It will hereafter appear that there are better arrangements than that shown by Fig. 1. The point which is proven is that, assuming a plain outside stack 29 ins. high



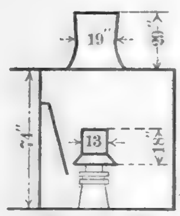
DRAFT, 4.54
FIG. 1



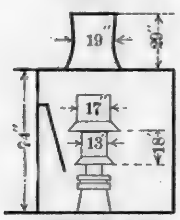
DRAFT, 5.20
FIG. 2



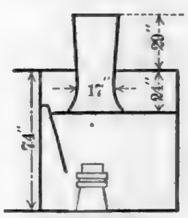
DRAFT, 4.71
FIG. 3



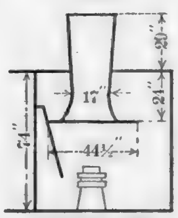
DRAFT, 4.55
FIG. 4



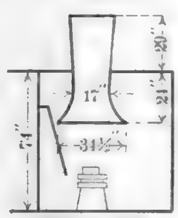
DRAFT, 4.40
FIG. 5



DRAFT, 5.06
FIG. 6



DRAFT, 5.05
FIG. 7



DRAFT, 4.98
FIG. 8

BEST ARRANGEMENT OF EACH TYPE OF FRONT END TESTED.

to be used, its diameter for the best results is 23 ins., as given.

A Comparison of Results Obtained From a Large Locomotive With Those Previously Obtained From a Smaller Locomotive.—Among the more important conclusions drawn from the AMERICAN ENGINEER'S tests of 1903, the following are of especial interest in connection with the present discussion:

That for a tapered stack, the diameter for best results does not change with changes in height.

That the diameter of stack is somewhat affected by the height of the exhaust tip, the diameter for the best results being greater as the nozzle tip is lowered.

That, calling *d* the diameter of the stack at its smallest part, and D the diameter of the front-end, the relation between the diameter of stack and front-end when the exhaust tip is at the center of the boiler is

$$d = .25D$$

That the diameter of stack must, for best results, be increased .16 in. for each inch that the exhaust tip is below the center-line of the boiler; that is, calling *h* the distance between the center-line and the tip.

$$d = .25D + .16\,h.$$

That a variation of an inch or more from the diameters given by the equation will produce no unfavorable result.

In view of the publicity that has been given these statements, it is important to determine the extent to which their truth is affected by the experiments of the present year.

As to the necessity for varying the diameter with the height of stack, the work of the past year is far less elaborate than that of 1903, but two heights of stack having been employed, namely, those of 29 and 47 ins. respectively. Comparing draft-values obtained from stacks of each of these heights under a uniform back pressure of 3.5 lbs., it appears that the best diameter for the 29-in. stack is 23 ins. The best results from the 47-in. stack were obtained by use of the largest diameter experimented upon (21 ins.). Curves plotted through the several points show this diameter to approach that for the maximum draft, but it does not equal it. The indication is that if a diameter of 23 ins. had been employed it would have been found right for the 47-in. height as well as for the 29-in. height. There is, in fact, nothing in the experiments of the present year to invalidate the conclusion derived from the preceding work. So far as outside stacks are concerned, therefore, the diameter does not need to be varied when the height is changed.

As to the effect, upon the proportions of stack, resulting from changes in the height of the exhaust tip, it must be noted that the work of the present year has involved one height of tip only, and hence gives no information upon this question. The validity of the conclusion already stated, however, has never been called in question, and it may be assumed to stand.

Concerning the actual size of stack for best results, the work of the present year points to the desirability of using diameters which are somewhat larger than those given by the equation of 1903. This equation is

$$d = .25D + .16\,h.$$

which, when applied to the N. Y. C. locomotive experimented upon, gives

$$d = .25 \times 74 + .16 \times 12.5 = 18.5 + 2.0 = 20.5$$

whereas, with a stack 29 ins. high, the best results were actually obtained when the diameter was 23 ins. The difference of 2.5 ins. is not great, especially in view of the fact that it has been distinctly noted that variation of an inch or more is not important. The difference is to be accounted for also by the fact that in reviewing the results of 1903 there was a common feeling on the part of the members of the advisory committee that the experiments pointed to dimensions which, for service conditions, were excessive. Because of this view, the equation was framed as a conservative expression of the experimental results. The data obtained during the present year might, for like reasons, be similarily treated, in which case the discrepancy of 2.5 ins. would be diminished or even be eliminated. Since, therefore, the only element of doubt concerning the results of 1903 has found expression in beliefs that they gave diameters which were too large, it is the feeling of your committee that the work of the present year may be accepted as a full confirmation of the earlier work.

Having shown the value of the work of the present year in confirming the conclusions of 1903, it remains to consider those phases of the present year's work which are to be regarded as extending beyond the scope of the earlier investigations; the effect of which necessarily diminishes the importance of that which has preceded. It will be shown that, however well the plain outside stack may be proportioned, the demands of service require it to give way to a more highly articulated device.

Inside Stacks.—The experiments included inside stacks of four different diameters, ranging from 15 to 21 ins., a constant outside height of 29 ins. and a penetration into the smokebox of 12, 24 and 36 ins. respectively. The best proportions of this form of stack are shown by Fig. 3 accompanying. Its diameter is 21 ins. and its penetration (P) into the smokebox is 12 ins. Results of nearly the same value were, however, obtained with stacks of smaller diameter

having greater penetration. Thus, 21-in. diameter, 12-in. penetration, gave a draft of 4.71; 19-in. diameter, 24-in. penetration, gave a draft of 4.55, and 17-in. diameter, 36-in. penetration, gave a draft of 4.32. From the values thus presented it appears that as the degree of penetration increases the diameter of stack should be reduced. The effect is, in fact, of the same nature and degree as that which results from raising the exhaust-tip. It is noteworthy also that these values for the plain inside stack are not materially better than those for the plain outside stack, a fact which was formulated as a conclusion resulting from the work of 1903.

Inside Stack With False Top.—It had been planned to fit the front-end with three different false tops located at 12, 24 and 36 ins. respectively from the top of smokebox, but the presence of the steam pipes made it difficult to fit the 12-in. top, and as a consequence only the 24- and 36in. drops were experimented upon. In each case stacks of different diameters were used, the outside height being always 29 ins. The best results were obtained with a stack 17 ins. in diameter, having a penetration of 24 ins., all as shown by Fig. 6. In all cases with the false top the 17-in. stacks gave best results. A comparison of these results with those quoted for plain outside stack and for plain inside stack show material improvement in draft values.

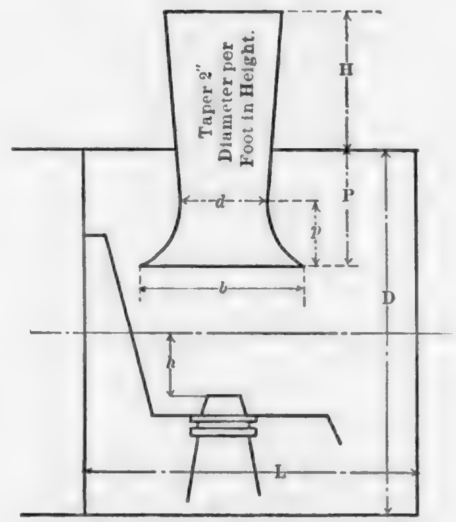
Substitutes for False Top.—The false top necessarily interferes with free access into the front-end, which fact makes it desirable that a way be found in which to secure the results derived from it by means which are more simple. It was suggested that experiments be made to determine the effect upon the plain inside stack of an annular ring or flange which might be considered as representing a portion of the false top. Responding to this suggestion, rings of two diameters were used on 17 and 19-in. stacks having a penetration of 24 ins. It was found that the proportions shown by Fig. 7 gave substantially the same results as those obtained with the best arrangement of false top. Believing that the results thus obtained pointed to the desirability of having a broader curve at the base of the stack, and that when the proper proportions were understood, the best results would be obtained from such a curved surface, the 17-in. stack was fitted with a bell, to which, for purposes of experimentation, flanges of various widths were afterward added, with the result that those proportions which appear in Fig. 8 proved most satisfactory. It will be noted that the best draft with the false top was 5.06; with the ring, 5.05, and with the bell, 4.98. That is, these three arrangements are practically on an equality. No other arrangements were experimented upon which gave higher draft values than these.

Single Draft-Pipes.—Draft-pipes of various diameters, adjusted to many different vertical positions, were tested in connection with plain stacks of the several diameters available. The elaboration of this phase of the work was very extensive. It was found that for the best results the presence of a draft-pipe requires a smaller stack than would be used without it, but that no possible combination of single draft-pipe and stack could be found which gave a better draft than could be obtained by the use of a properly proportioned stack without the draft-pipe. While the presence of a draft-pipe will improve the draft when the stack is small, it will not do so when the stack is sufficiently large to serve without it. The best proportion and adjustment of a single draft-pipe and stack are shown by Fig. 4.

Double Draft-Pipes.—Double draft-pipes of various diameters and lengths, and having many different positions within the front-end, all in combination with stacks of different diameters, were included in the experiments with results which justify a conclusion similar to that reached with reference to the single draft-pipe. Double draft-pipes make a small stack workable. They cannot serve to give a draft equal to that which may be obtained without them, provided the plain stack is suitably proportioned. The arrangements and proportions giving the best results are those shown by Fig. 5.

The Length of Front-End.—The experiments involving different lengths of front-end only appear to be inconclusive. The range of these experiments included the length of front-end normal to the locomotive, which is 65.75 in., with successive reductions therefrom of 4½, 8 7/16 and 20 ins. respectively, obtained in each case by fitting in a false-front. The fitting was well done, the work being made practically tight, notwithstanding which fact it was found that the longest and shortest ends experimented with gave practically identical results, while the lengths between these limits gave results which were somewhat inferior. The peculiar character of the results as first obtained led to a complete duplication of the work after a considerable interval had elapsed, with results which were identical with those first obtained. So far as the experimental results give a solution to this problem, they point to a length of 66 or 46 ins. as equally satisfactory and suggest that intermediate lengths are to be avoided.

A Suggestion as to a Standard Front-End is presented as Fig. 9, which, with the following equations referring thereto,



BEST ARRANGEMENT OF FRONT END

may be accepted as a summary of the conclusions to be drawn from all experiments made.

For best results, make H and h as great as practicable.

Also make, $d = .21D + .16h$
$b = 2d$ or $.5D$
$P = .32D$
$p = .22D$
$L =$ (not well established).
$= .6D$ or $.9D$ but not of intermediate values.

While the drawing is a simple one, to be put forth as a result of so elaborate a series of experiments, it goes without saying that the latter have been valuable quite as much for the things they prove useless as for the proportions of details which they serve to define. For example, it will be seen that the suggested standard does not include draft-pipes, and that it includes a stack of comparatively large diameter having a bell as the lower end of dimensions quite beyond those now common in American practice.

Respectfully submitted,

H. H. Vaughan,
F. H. Clark,
Robert Quayle,
A. W. Gibbs,
W. F. M. Goss,
G. M. Basford,
Committee.

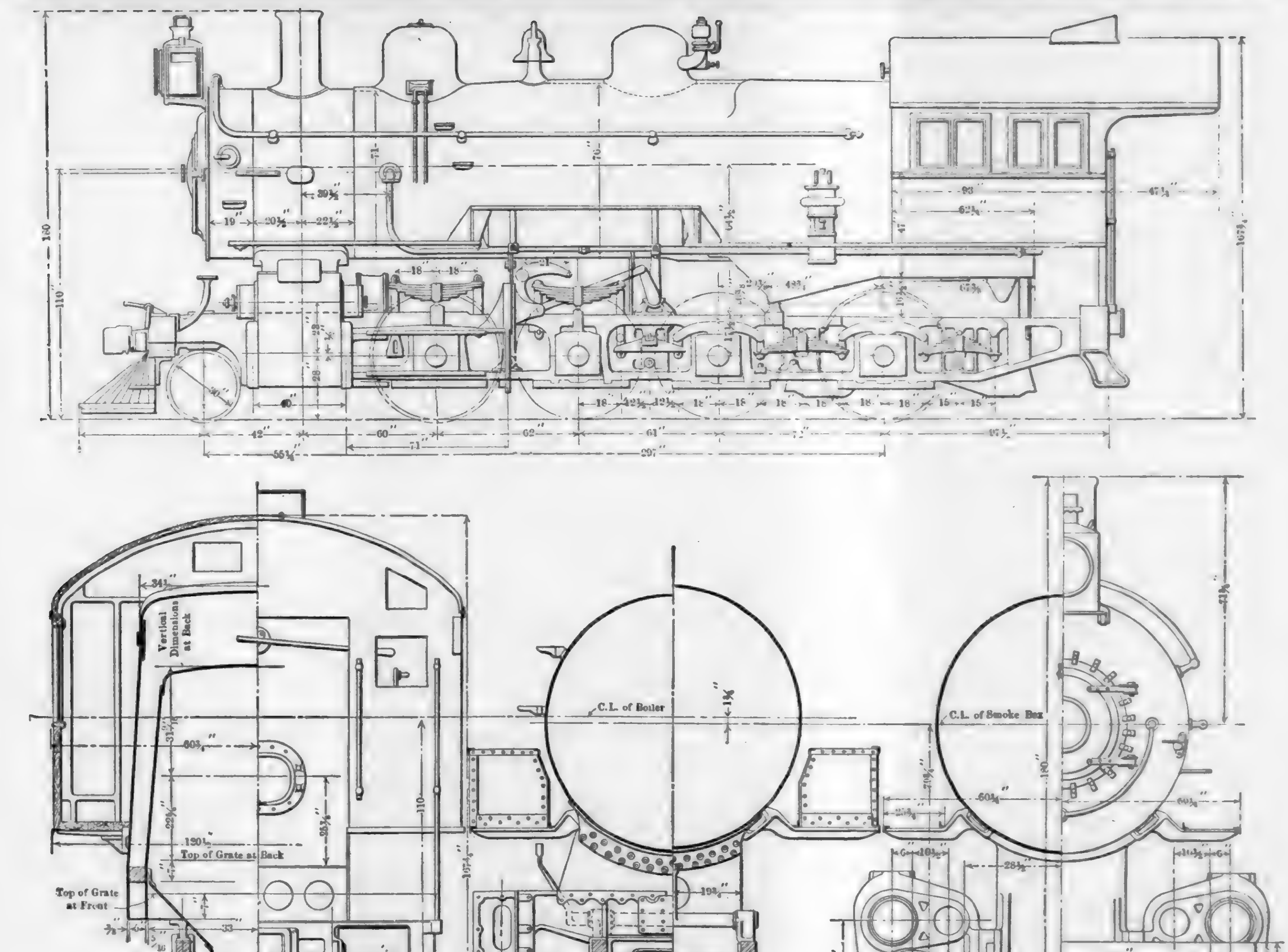
The American Society for Testing Materials.—The ninth annual meeting of this association will be held at Atlantic City, N. J., June 21 to 23.

SIMPLE CONSOLIDATION LOCOMOTIVE WITH WALSCHAERT VALVE GEAR.

PENNSYLVANIA RAILROAD.

For a number of years the standard consolidation locomotive in use on the Pennsylvania Railroad has been a 22- by 28-in. simple engine with slide valves, 56-in. wheels, 70-in. Belpaire boiler, and weighing 194,200 lbs. This engine was titled Class H6A in the railroad company's classification, and one of this type was the first locomotive tested on the Pennsylvania Railroad's testing plant at St. Louis, where it gave a most satisfactory account of itself, as shown by the results published in the report of these tests issued by the company.

Recently, in considering an increase of this type of power, it was decided to apply the Walschaert valve gear and piston valves to the new engines, but in other respects to stick very closely to the dimensions and parts of H6A. An order of

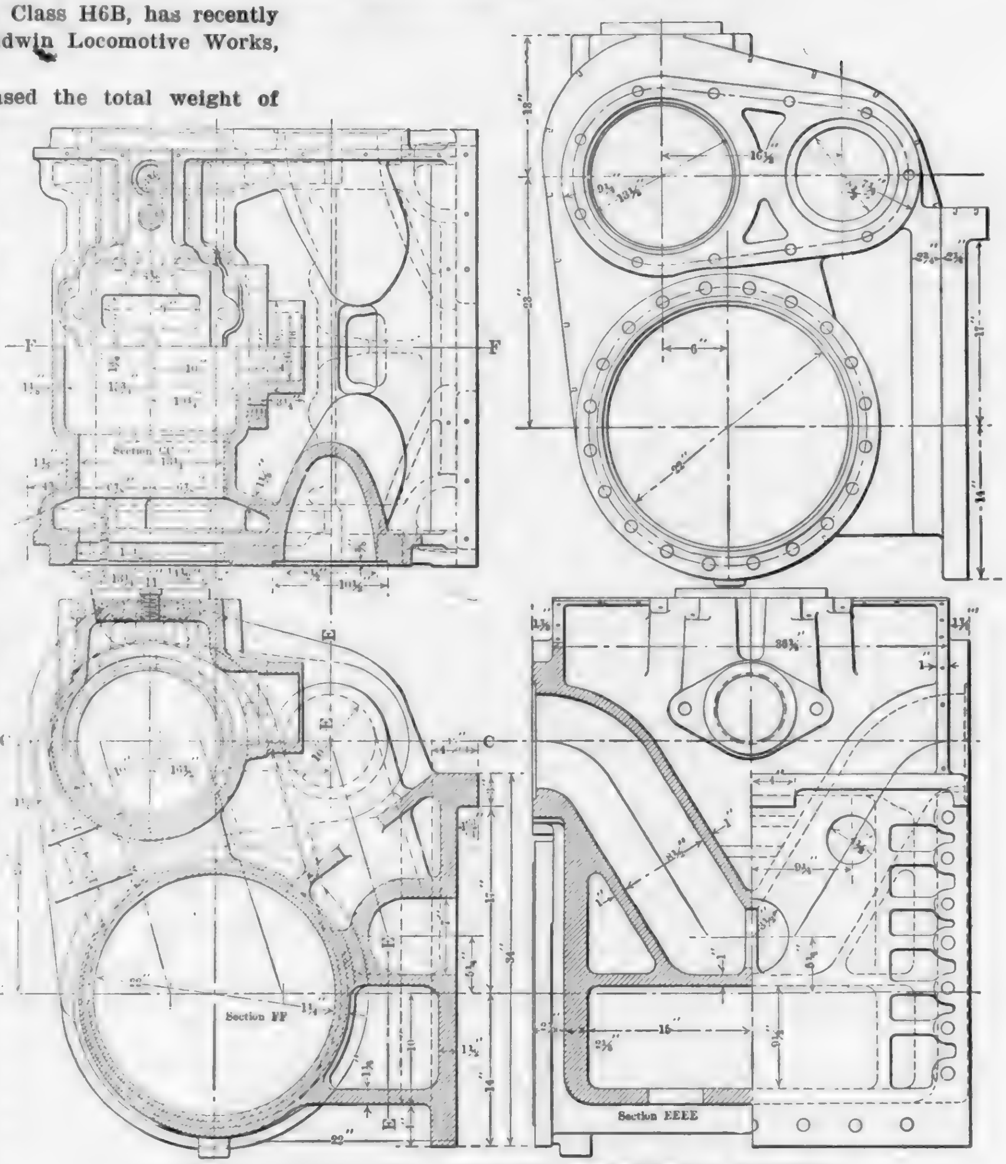


CONSOLIDATION LOCOMOTIVE, WITH WALSCHAERT VALVE GEAR.—PENNSYLVANIA RAILROAD.

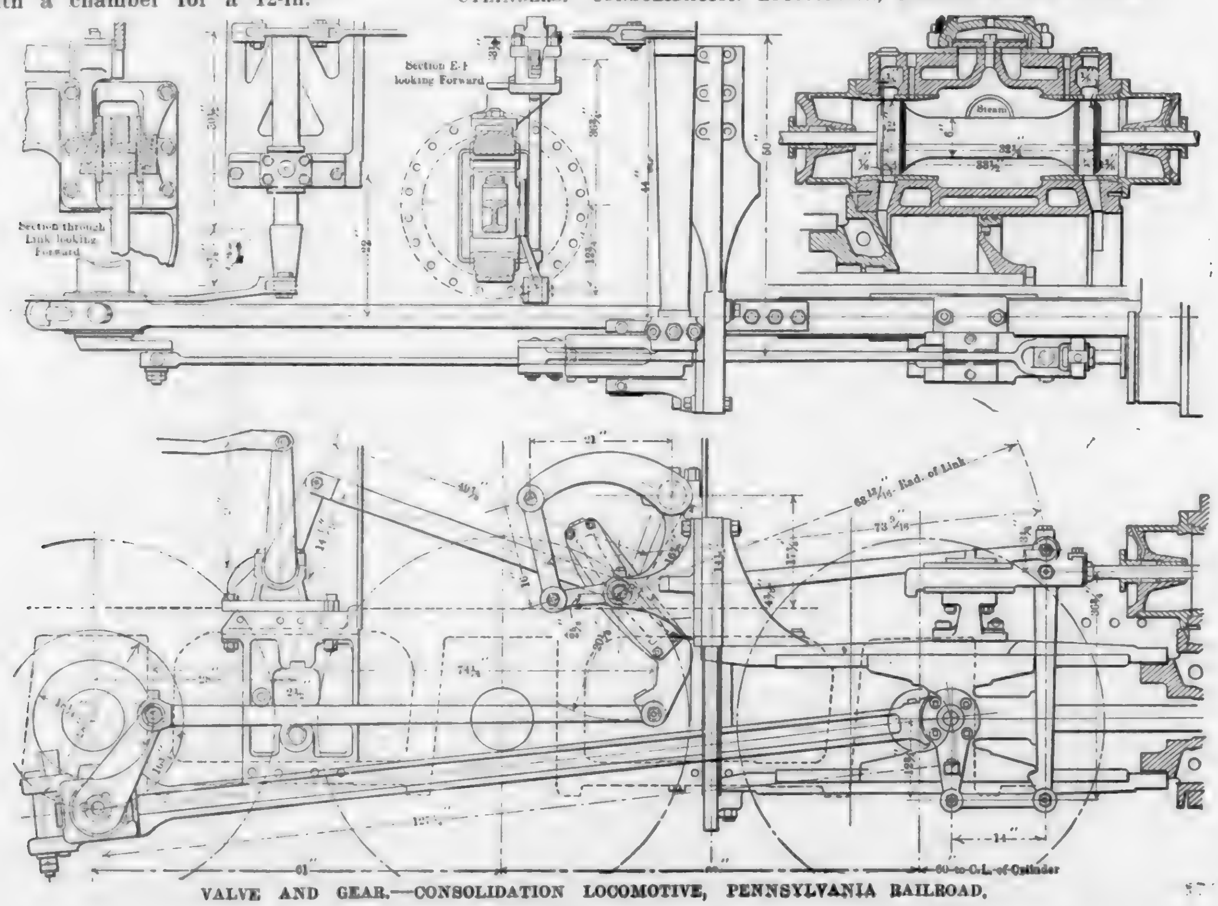
this newer type, which is known as Class H6B, has recently been built and delivered by the Baldwin Locomotive Works, and is illustrated herewith.

The change in design has increased the total weight of the engine somewhat, making this latter class weigh over 200,000 lbs., of which over 177,000 lbs. is on drivers. The tractive power figured at 85 per cent. boiler pressure is 42,200 lbs., which gives an adhesive ratio of 4.2. The engine as a whole is a simple and straightforward consolidation engine with a Belpaire boiler, and contains nothing particularly unusual outside the new features as applied to the H6B. The report of the locomotive tests at St. Louis contains a thorough description of the Class H6A, to which reference can be made for most of the details of this engine.

The new design of cylinders using piston valves contains a number of new and interesting features. As has been the custom for this type of power on this road they are cast with a separate saddle, a plate frame passing between the cylinders and the saddle, the whole construction being securely bolted together. The passage for live steam in the saddle opens above the frame connection and is continued by a short pipe with ground joints extending directly to the valve chamber. The exhaust passage, however, is in its usual place in the saddle casting, and an opening is cut in the plate frame connecting the passage from the cylinder casting. The cylinders are cast with a chamber for a 12-in.



CYLINDERS.—CONSOLIDATION LOCOMOTIVE, PENNSYLVANIA RAILROAD.



VALVE AND GEAR.—CONSOLIDATION LOCOMOTIVE, PENNSYLVANIA RAILROAD.

piston valve located above and 6 ins. outside the centers of the cylinders. The construction of this chamber is such that the steam ports into the cylinder are almost vertical and in itself it has no exhaust passage, this passage being formed in the heads, which are elongated and connect the end of the valve chamber with the opening forming the end of the cored exhaust passages, which is just inside of and on a line with the valve chamber.

The piston valve, which is somewhat longer than the stroke of the engine, has an extended valve rod which passes through the front head and is fastened at the rear to a small crosshead running in a guide bolted to the top guide bar. This crosshead has a connection to the combination lever of the Walschaert valve gear below the connection to the radius arm.

One of the governing features which led to the use of the Walschaert valve gear on this class was the fact that the removal of the eccentrics and motion work between the frames allowed space for the introduction of a more substantial and satisfactory frame bracing. In making the application of this gear it was necessary to considerably strengthen the guide yoke for carrying the large overhanging weight of the link and connections, and this has been done by making it of cast-steel in two sections, which are fastened to the frame and boiler brace as well as a heavy steel frame brace of open section which is placed between and stiffens all four bars of the frame. The reverse shaft has been left in its old location and has an upward extension arm in its centre which connects to the downwardly extending arm of the reverse shaft extending across beneath the boiler back of the guide yoke, to which the radius arms of the Walschaert gear are connected through hangers in the manner shown in the illustration.

The other features of this very powerful and well arranged locomotive will be made clear by reference to the illustrations and following table of dimensions:

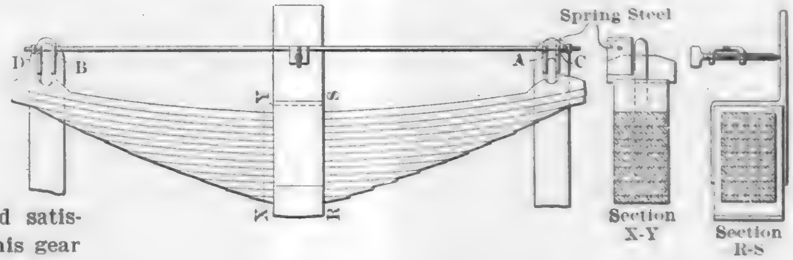
CONSOLIDATION LOCOMOTIVE, WALSCHAERT VALVE GEAR.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Freight
Fuel	Bit. coal.
Tractive power	42,200 lbs.
Weight in working order	200,380 lbs.
Weight on drivers	177,320 lbs.
Weight on leading truck	23,060 lbs.
Weight of engine and tender in working order	332,000 lbs.
Wheel base, driving	16 ft. 3 ins.
Wheel base, total	24 ft. 9 ins.
Wheel base, engine and tender	55 ft. 2¾ ins.
RATIOS.	
Weight on drivers ÷ tractive effort	4.2
Total weight ÷ tractive effort	4.75
Tractive effort x diam. drivers ÷ heating surface	823
Total heating surface ÷ grate area	58.1
Firebox heating surface ÷ total heating surface	6.4%
Weight on drivers ÷ total heating surface	62
Total weight ÷ total heating surface	70
Volume both cylinders	12.3 cu. ft.
Total heating surface ÷ vol. cylinders	233
Grate area ÷ vol. cylinders	4
CYLINDERS.	
Kind	Simple
Diameter and stroke	22 x 28 ins.
Valves	Piston
Diameter	12 ins.
WHEELS.	
Driving, diameter over tires	56 ins.
Driving, thickness of tires	3 ins.
Driving journals, main, diameter and length	9 x 13 ins.
Driving journals, others, diameter and length	9 x 13 ins.
Engine truck wheels, diameter	30 ins.
Engine truck, journals	5½ x 10 ins.
BOILER.	
Style	Belpaire
Working pressure	205 ins.
Outside diameter of first ring	71 ins.
Firebox, length and width	107⅛ x 66 ins.
Firebox plates, thickness	5-16, ⅜, ½ in.
Firebox, water space	5 ins.
Tubes, number and outside diameter	373, 2-in.
Tubes, length	13 ft. 9½ ins.
Heating surface, tubes	2,677 sq. ft.
Heating surface, firebox	182 sq. ft.
Heating surface, total	2,859 sq. ft.
Grate area	49.11 sq. ft.
TENDER.	
Tank	Waterbottom
Frame	Steel
Wheels, diameter	33 ins.
Journals, diameter and length	5½ x 10 ins.
Water capacity	7,000 gals.
Coal capacity	14 tons

SEMI-ELLIPTIC SPRINGS FOR LOCOMOTIVES AND TENDERS.

BY WILLIAM H. MUSSEY.

The proper design of locomotive and tender springs is a very important factor in securing the best results from the heavy motive power which has come into use. They are in many cases made to fit the design of frame, boiler, etc., and even then are not always given the attention they should have. Several years ago the writer made a number of tests to



determine just what loads driving springs were subjected to in service. A recorder was made, as shown in the illustration, to register the deflections produced by service conditions. Ample play was allowed at C and D and a moving fit at A and B. The pointer was threaded and the tension on the plate was regulated, as desired, by hand. At times a check nut was placed on the pointer, bearing against the inverted U-shaped section of the rod, to guard against its screwing in or out.

With the recorder in place and the engine on a level track, a horizontal line was drawn to designate the static load. The springs had all been tested, before being applied, both for free height (set), static working load and a test load, so that the loads corresponding to the various heights were known. The horizontal line, which was used as a basis for the test, was found to check closely with the height obtained for the static working load by the manufacturer. The marks made on the plate, which was chalked, by the pointer gave the maximum and minimum deflections due to service conditions. From these deflections, which were measured from the base line, previously established, the corresponding actual loads were determined. The greatest value for the live load was found to be about 65 per cent. above the static working load, and the minimum 45 per cent. less than the static working load. These figures were obtained from a number of engines on which the spring rigging was considered satisfactory, and were obtained at cross-overs, switches and moving on and off turn-tables, thus representing very severe conditions.

Having gained an insight into the service demands, it was possible to more readily decide on the necessary requirements for a satisfactory spring. Introducing an arbitrary factor of safety, it was decided that in designing springs the plates should come within 3-16 in. of the horizontal for a load equivalent to twice the static working load, whenever it was possible with the conditions imposed by the locomotive construction; also that the fibre stress at this point should not exceed 130,000 lbs. per sq. in. The 3-16 in. is the construction variation allowed the manufacturers by many specifications, which state that heights for given loads must not vary more than 3-16 in. above or below those specified. With the utmost permissible variation, therefore, the plates will not pass the horizontal for a load equal to twice the static working load. The 3-16-in. allowance is entirely arbitrary, and has no relation to the total deflection of the spring, as it should. However, it is satisfactory to the manufacturer and also the railroad, and in no case in a well-designed locomotive spring have we found this allowance excessive.

By watching closely the life and service conditions of springs it was found that a good figure for the fibre stress per square inch under the static working load was between 60,000 and 65,000 lbs.; 70,000 lbs. is permissible, but 75,000

lbs. is too high, and limits the life of the spring. This latter figure means that for a possible live load the stress goes above 120,000 lbs. per sq. in., and repeated strains at that figure should be avoided with the average open-hearth steel. Our experience with springs has proved this conclusively. We specify a test load height, and fix this load so it produces a fibre stress of about 120,000 lbs. per sq. in. This is a precaution to insure a high-grade spring. The stress of 130,000 lbs. per sq. in. we might call our ultimate figure; we don't expect springs (open-hearth steel) to stand loads exceeding this even at rare intervals.

These springs are designed by the Reauleaux formulæ for semi-elliptic springs:

$$P = \text{(static load on one end)} = \frac{Snbh^2}{6L}$$

$L = \frac{1}{2}$ span in inches less $\frac{1}{4}$ width of band.
S = fibre stress per sq. in.
b = width of plate in inches.
h = thickness of plate in inches.
n = number of plates.

FOR DEFLECTIONS.

$$D = \frac{6PL^3}{Enbh^3}$$

Equating for value of P.

$$D = \frac{SL^2}{Eh^2}$$

E = modulus of elasticity = 29,400,000.

There may be some question about the deduction from L of one-quarter the width of the band, but this is theoretically correct as a study of the action of the leaves of a spring will show. Springs designed on this basis will be guaranteed by the spring manufacturers for one year's service, and in practice they far exceed it. Springs so designed are still in service at the end of two years and show no signs of failure, and we confidently expect a continued satisfactory service for some time to come. The lower the fibre stress the longer the life of the spring within reasonable limits. To indicate the severe service that these springs are subjected to, it might be added that they are used on a road which has very little stone ballast.

In designing springs it should be the aim as nearly as possible to have equal deflections under the working loads for those springs which are equalized together. When possible short springs should be avoided and also narrow ones. Long springs with wide plates give the most even deflections, taking up shocks more effectively. On short springs, 24, 26 or 28-in. spans, it is better to use thin plates ¼ to 5-16 in. thick. As the length of span increases the thickness of plate should also be increased; for a 48-in. span ⅝-in. or even 11-16-in. leaves are not excessive. In one case a spring with a span of 26 ins. and ⅜-in. leaves was equalized with a spring having a 38-in. span and 7-16-in. plates and gave poor service, although the fibre stress was comparatively low. By reducing the thickness of the plates and with about the same fibre stress much better results were obtained. The aim is to increase the deflections for given loads on short springs, where it is naturally small, and to decrease them on long springs, where it is, on the other hand, excessive. By examining the formula for deflections $D = \frac{SL^2}{Eh^2}$ we find that deflections for a given load vary directly as the square of L, and inversely as the square of the thickness. From this the relation that thickness bears to the length is apparent.

Good practice is to keep the deflection from the free height to the static working load between 1½ and 2¼ ins. where possible. The former figure covers short springs, the latter longer ones; conditions, however, do not always permit this. The width of the bands should be about one-tenth the span of the spring. All of the foregoing applies more especially to driving springs. For engine truck and tender truck springs the service conditions are not as exacting. The springs may be stiffer, the fibre stress decreased and the life of the spring thus increased; in no case, however, is the use of leaves over 11-16 in. thick recommended. To reduce the fibre stress it is better to use wider plates, if possible, even though clearances require them to be reduced in width at the hanger.

FORGING AT THE COLLINWOOD SHOPS.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

On page 143 of our April issue we illustrated and described a number of forgings which are being manufactured in the forging and bulldozing machines and under a Bradley hammer at the Collinwood shops of the Lake Shore & Michigan Southern Railway. The value of these machines depends entirely on their being properly equipped with special tools and dies for the different parts to be manufactured, and if these are provided the rate at which forgings can be turned out is usually limited only by the facilities for heating the iron. Not only is it thus possible to greatly increase the output of the shop, but the grade of work turned out is superior to that done by other methods. In this article, which supplements the earlier one, the dies and formers for making several of the more intricate forgings are illustrated.

FIG. 1.—GENERAL VIEW OF THE MANUFACTURING SECTION OF THE COLLINWOOD SMITH SHOP.

One of the illustrations shows a general view of the manufacturing section of the smith shop. In the foreground, to the right, is a No. 3½ Ajax forging machine, the largest forging machine used in the shop. Just to the rear of it is a No. 6 and also a No. 8 Williams and White bulldozer. The No. 8 machine is served by a jib crane, so that the heavy cast-iron formers can readily be transferred from the storage platform, indistinctly shown in the background, to the machine. At the right and just opposite the No. 6 bulldozer is a large punch and shear. A 200-lb. Bradley hammer, to the left and

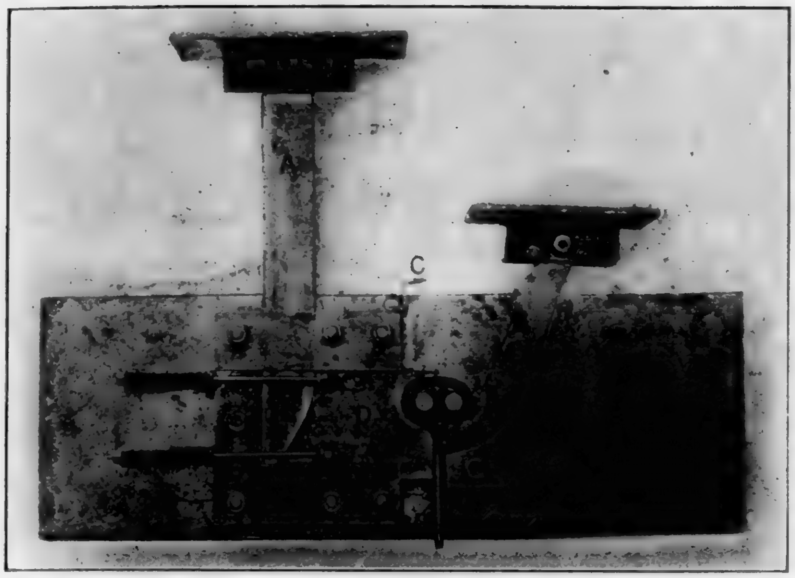


FIG. 2.

not shown in this view, is also used to considerable advantage in connection with the manufacturing work. In the foreground may be seen a number of truss rod anchors, safety chain hooks in the first stage of manufacture, baggage car carlines and coupler pockets in various stages, which are made by these machines.

Fig. 2 shows a device which was built at the Collinwood shops, and is used on the bulldozer for forming the handles of ash hoes and hooks. These handles are formed and completed cold. As it is possible to make one complete handle for every stroke of the machine, without heating the iron, a considerable saving has been effected over former methods. The photograph does not, of course, show the relative position of the wedge and cam when the machine is in operation, but the operation of the device can readily be understood from the following description. The wedge A and the cam B are fastened to the face plate of the bulldozer by means of the brackets shown at their upper ends. A straight bar of iron is placed against the stop C. As the crosshead of the bulldozer advances the wedge A forces the head D forward, completing the first half of the handle, and leaving the end at right angles to the original bar. At this point the cam B comes in contact with the guide E, forcing the end of the handle to the position shown and completing it.

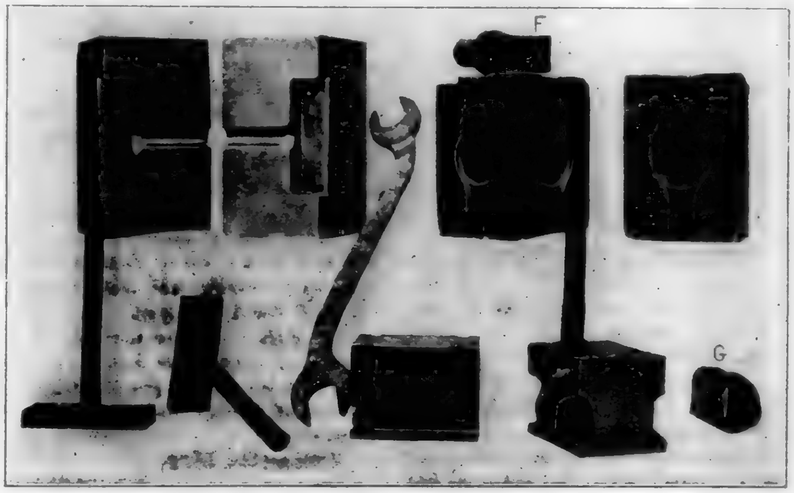


FIG. 3.

Fig. 3 shows a back flue sheet brace similar to the ones which are being manufactured in the forging machine. The end of a piece of ¾ by 2½-in. iron is first swaged under the Bradley hammer forming the round bar. A hole is then punched in the rectangular piece which forms the foot and the round bar is entered, heated to a welding heat, and is formed in the forging machine, in the dies shown in the upper left-hand corner. This method is very much more satisfactory than that of drawing the brace out from the solid, and produces a better brace.

At the right, in this view, are shown the tools for forming wrenches in the forging machine from round steel bar. In the first operation the end of the bar is placed between the two upper dies and flattened, and is formed into a blank by the plunger F. In the second operation the blank is placed in the lower dies, and the opening is punched to the proper size by the punch G. The center of the wrench is then flattened out under the Bradley hammer and is bent to the finished shape as shown.

Fig. 4 shows at the right a driver brake adjusting rod, which is finished complete in the forging machine. A rectangular head is first formed on the end of the round bar of iron. A plain piece is sheared from a rectangular bar for the opposite end. Two pieces of 2½ by ¾-in. iron are then clamped on the rectangular head of the stem end, are heated to a welding heat, placed in the dies shown in the upper right-hand corner, and the ram H is forced over the bar or stem, making a complete weld in one operation. The dies are then reversed, the crosshead is placed in position, and the blank end is inserted between the two forks, heated to a welding heat, and the ram I is forced against the blank block while it is gripped in the jaws, punching a hole and welding complete in one operation. With this arrangement a saving of 70 per cent. is effected over hand forging and a better forging is obtained.

At the left are shown the dies and plungers for forming the brake rod for the standard four-wheel steel passenger trucks. This connecting rod is 5 ft. long with a fork at each end. It is made of 2½-in. double, extra strong wrought iron pipe. A piece of round iron is placed in the end of the pipe, heated to a welding heat, and the square is formed in the dies, shown above, with a blank plunger, which is not shown. The opening is then sheared out with the ram J and completed with the former K, which shapes the end and regulates the width and thickness, form-

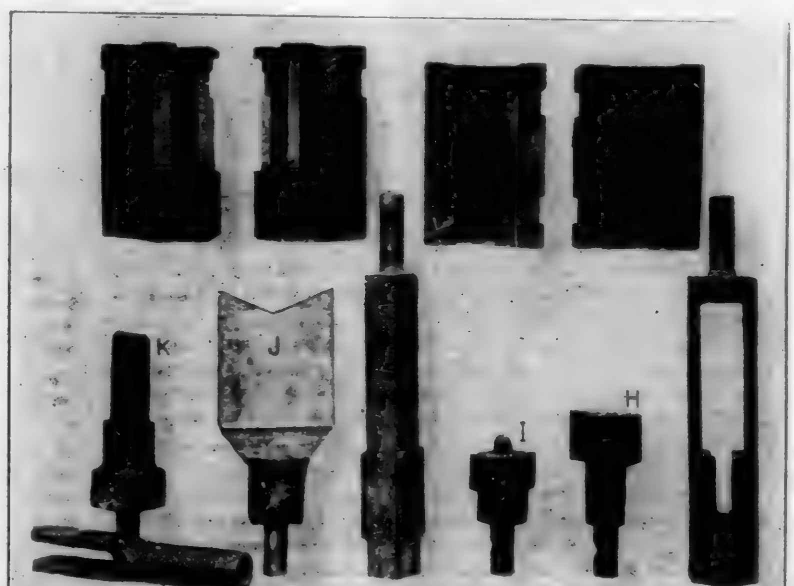


FIG. 4.

lbs. is too high, and limits the life of the spring. This latter figure means that for a possible live load the stress goes above 120,000 lbs. per sq. in., and repeated strains at that figure should be avoided with the average open-hearth steel. Our experience with springs has proved this conclusively. We specify a test load height, and fix this load so it produces a fibre stress of about 120,000 lbs. per sq. in. This is a precaution to insure a high-grade spring. The stress of 130,000 lbs. per sq. in. we might call our ultimate figure; we don't expect springs (open-hearth steel) to stand loads exceeding this even at rare intervals.

These springs are designed by the Reauleaux formulæ for semi-elliptic springs:

$$P = (\text{static load on one end}) = \frac{Snbh^2}{6L}$$

L = ½ span in inches less ¼ width of band
S = fibre stress per sq. in.
b = width of plate in inches.
h = thickness of plate in inches.
n = number of plates.

FOR DEFLECTIONS.

$$D = \frac{6PL^3}{Enbh^3}$$

Equating for value of P.

$$D = \frac{SL^2}{Eh^2}$$

E = modulus of elasticity 29,000,000

There may be some question about the deduction from L of one-quarter the width of the band, but this is theoretically correct as a study of the action of the leaves of a spring will show. Springs designed on this basis will be guaranteed by the spring manufacturers for one year's service, and in practice they far exceed it. Springs so designed are still in service at the end of two years and show no signs of failure, and we confidently expect a continued satisfactory service for some time to come. The lower the fibre stress the longer the life of the spring within reasonable limits. To indicate the severe service that these springs are subjected to, it might be added that they are used on a road which has very little stone ballast.

In designing springs it should be the aim as nearly as possible to have equal deflections under the working loads for those springs which are equalized together. When possible short springs should be avoided and also narrow ones. Long springs with wide plates give the most even deflections, taking up shocks more effectively. On short springs, 24, 26 or 28-in. spans, it is better to use thin plates ¼ to 5-16 in. thick. As the length of span increases the thickness of plate should also be increased; for a 48-in. span ⅝-in. or even 11-16-in. leaves are not excessive. In one case a spring with a span of 26 ins. and ⅜-in. leaves was equalized with a spring having a 38-in. span and 7-16-in. plates and gave poor service, although the fibre stress was comparatively low. By reducing the thickness of the plates and with about the same fibre stress much better results were obtained. The aim is to increase the deflections for given loads on short springs, where it is naturally small, and to decrease them on long springs, where it is, on the other hand, excessive. By examining the formula for deflections $D = \frac{SL^2}{Eh^2}$ we find that deflections for a given load vary directly as the square of L, and inversely as the square of the thickness. From this the relation that thickness bears to the length is apparent.

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FORGING AT THE COLLINWOOD SHOPS.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

On page 143 of our April issue we illustrated and described a number of forgings which are being manufactured in the forging and bulldozing machines and under a Bradley hammer at the Collinwood shops of the Lake Shore & Michigan Southern Railway. The value of these machines depends entirely on their being properly equipped with special tools and dies for the different parts to be manufactured, and if these are provided the rate at which forgings can be turned out is usually limited only by the facilities for heating the iron. Not only is it thus possible to greatly increase the output of the shop, but the grade of work turned out is superior to that done by other methods. In this article, which supplements the earlier one, the dies and formers for making several of the more intricate forgings are illustrated.

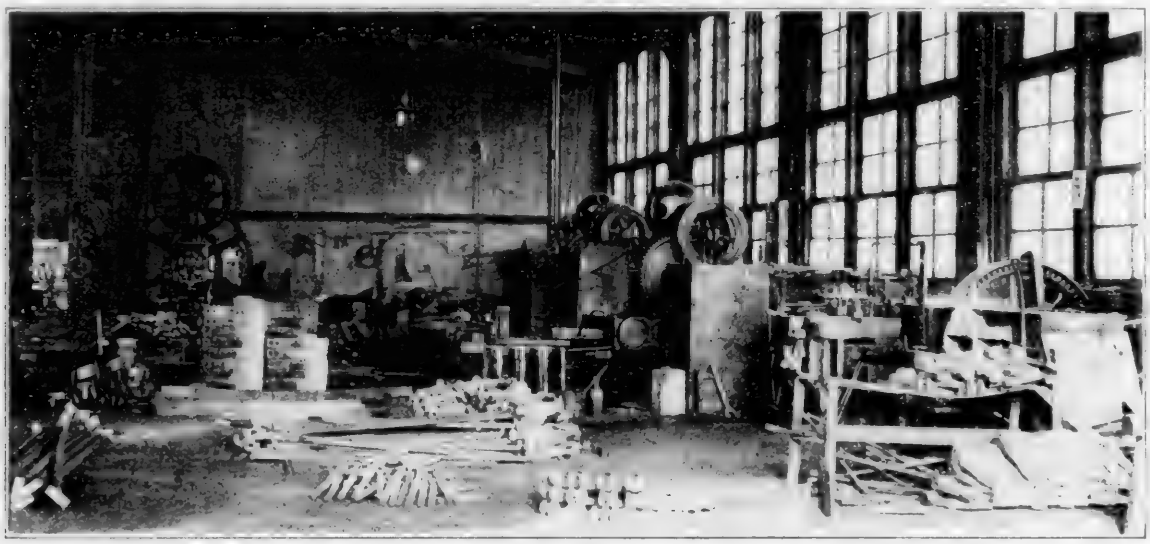


FIG. 1.—GENERAL VIEW OF THE MANUFACTURING SECTION OF THE COLLINWOOD SMITH SHOP.

One of the illustrations shows a general view of the manufacturing section of the smith shop. In the foreground, to the right, is a No. 3½ Ajax forging machine, the largest forging machine used in the shop. Just to the rear of it is a No. 6 and also a No. 8 Williams and White bulldozer. The No. 8 machine is served by a jib crane, so that the heavy cast-iron formers can readily be transferred from the storage platform, indistinctly shown in the background, to the machine. At the right and just opposite the No. 6 bulldozer is a large punch and shear. A 200-lb. Bradley hammer, to the left and

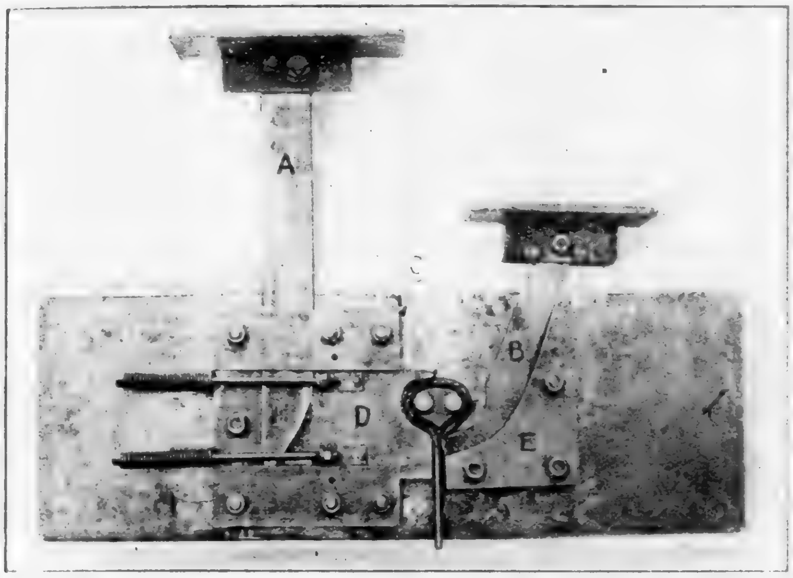


FIG. 2.

not shown in this view, is also used to considerable advantage in connection with the manufacturing work. In the foreground may be seen a number of truss rod anchors, safety chain hooks in the first stage of manufacture, baggage car carlines and coupler pockets in various stages, which are made by these machines.

Fig. 2 shows a device which was built at the Collinwood shops, and is used on the bulldozer for forming the handles of ash hoes and hooks. These handles are formed and completed cold. As it is possible to make one complete handle for every stroke of the machine, without heating the iron, a considerable saving has been effected over former methods. The photograph does not, of course, show the relative position of the wedge and cam when the machine is in operation, but the operation of the device can readily be understood from the following description. The wedge A and the cam B are fastened to the face plate of the bulldozer by means of the brackets shown at their upper ends. A straight bar of iron is placed against the stop C. As the crosshead of the bulldozer advances the wedge A forces the head D forward, completing the first half of the handle, and leaving the end at right angles to the original bar. At this point the cam B comes in contact with the guide E, forcing the end of the handle to the position shown and completing it.

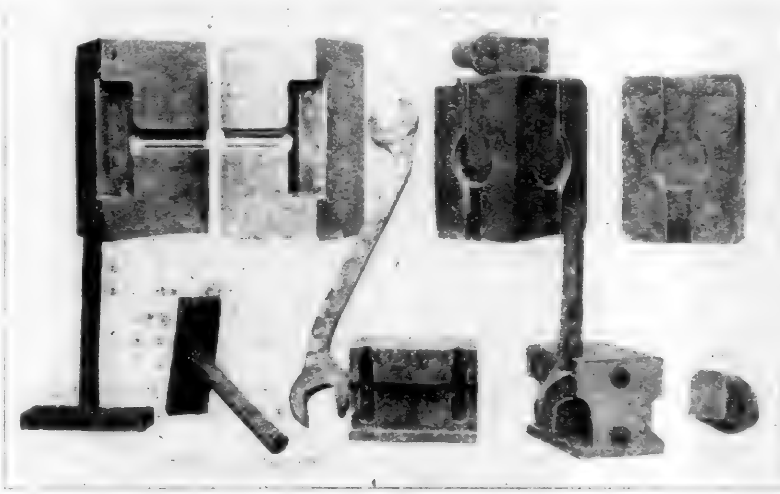


FIG. 3.

Fig. 3 shows a back flue sheet brace similar to the ones which are being manufactured in the forging machine. The end of a piece of ¾ by 2½-in. iron is first swaged under the Bradley hammer forming the round bar. A hole is then punched in the rectangular piece which forms the foot and the round bar is entered, heated to a welding heat, and is formed in the forging machine, in the dies shown in the upper left-hand corner. This method is very much more satisfactory than that of drawing the brace out from the solid, and produces a better brace.

At the right, in this view, are shown the tools for forging wrenches in the forging machine from round steel bar. In the first operation the end of the bar is placed between the two upper dies and flattened, and is formed into a blank by the plunger F. In the second operation the blank is placed in the lower dies, and the opening is punched to the proper size by the punch G. The center of the wrench is then flattened out under the Bradley hammer and is bent to the finished shape as shown.

Fig. 4 shows at the right a driver brake adjusting rod, which is finished complete in the forging machine. A rectangular head is first formed on the end of the round bar of iron. A plain piece is sheared from a rectangular bar for the opposite end. Two pieces of 2½ by ¾-in. iron are then clamped on the rectangular head of the stem end, are heated to a welding heat, placed in the dies shown in the upper right-hand corner, and the ram H is forced over the bar or stem, making a complete weld in one operation. The dies are then reversed, the crosshead is placed in position, and the blank end is inserted between the two forks, heated to a welding heat, and the ram I is forced against the blank block while it is gripped in the jaws, punching a hole and welding complete in one operation. With this arrangement a saving of 70 per cent. is effected over hand forging and a better forging is obtained.

At the left are shown the dies and plungers for forming the brake rod for the standard four-wheel steel passenger trucks. This connecting rod is 5 ft. long with a fork at each end. It is made of 2½-in. double, extra strong wrought iron pipe. A piece of round iron is placed in the end of the pipe, heated to a welding heat, and the square is formed in the dies, shown above, with a blank plunger, which is not shown. The opening is then sheared out with the ram J and completed with the former K, which shapes the end and regulates the width and thickness; form

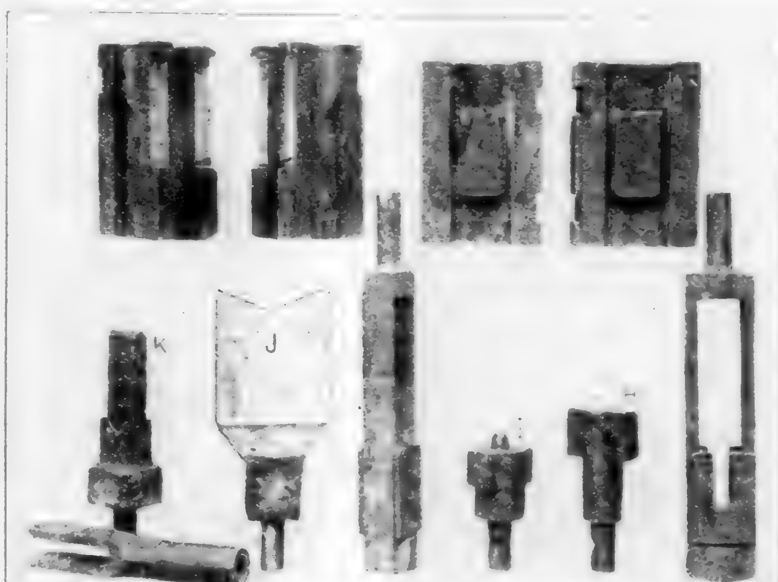


FIG. 4.

ing the completed end as shown. This operation has effected a saving on the piece work prices of 75 per cent. over the hand method of making these rods.

At the right in Fig. 5 are shown the dies and the method of forming the yoke for raising and lowering the water scoop dippers on tenders. M shows the blank after it has been punched by the ram N and the dies, shown at the right. O shows the lugs, which are punched from bar stock, cold. Both lugs are placed in the blank M, heated to a welding heat and welded on a hand block in the forging machine, using a plain rectangular ram, which is not shown. As will be noted, the attachment of the lugs to the bar is very neatly made.

At the left are shown the dies for forming the standard connection, P, for the expansion sling stays. These are formed from $1\frac{1}{8}$ by $2\frac{1}{2}$-in. iron. The end is first pinched in the dies preparatory to forming the round base. The bar is then moved forward the proper distance, and as the dies come together the end is sheared off, as will readily be understood by referring to the photographs of the dies. It is held in the pocket while the ram Q comes forward compressing the stock and forming the hole which is threaded to receive the crown bolt. This is formed in one heat and one operation. We are indebted for information to Mr. M. D. Franey, superintendent of the Collinwood shops.

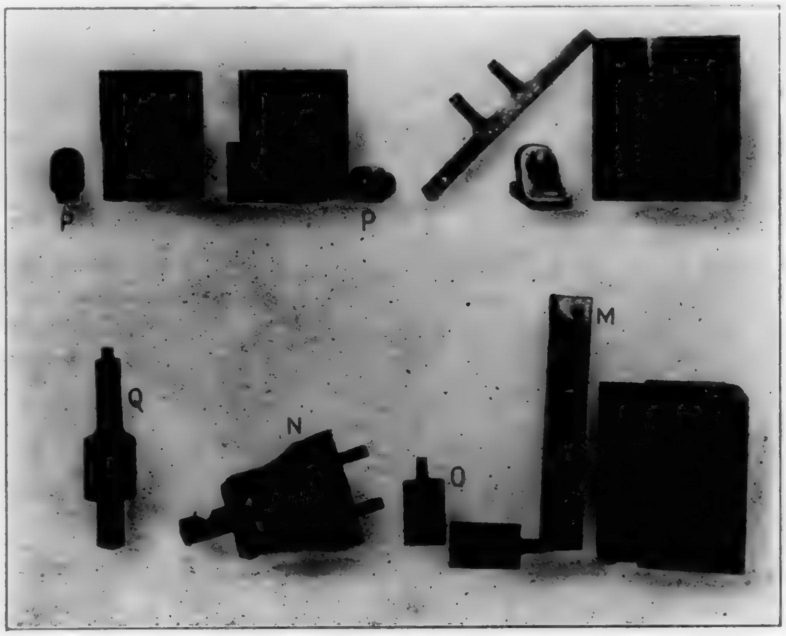


FIG. 5.

COMMUNICATIONS.

FINISH ON PATTERNS.

To the Editor:

Considerable improvement may be made over general practice by railroad companies in the matter of constructing patterns for castings more nearly to the desired size by cutting down the amount of "finish" allowed on machined surfaces. Too often this matter is left to the discretion of the pattern maker, and he, not knowing the exact requirements of, or degree of accuracy necessary on the part in hand, adds from one-sixteenth to a quarter of an inch finish, as he sees fit. It seems best that the amount of finish a piece is to have should be decided by the engineering department, where all conditions as to requirements of the part are known. *Where* parts should be finished should be marked as well as the *amount* of finish. Few better systems for marking the amount of finish on drawings are in use than the following: Surfaces requiring one-thirty-second of an inch finish, mark thus $\frac{1}{F}$; those requiring one-sixteenth of an inch, $\frac{2}{F}$; those requiring three-thirty-seconds of an inch, $\frac{3}{F}$; etc. The figure placed above the "F" denotes the number of thirty-seconds thickness of finish desired. By the use of this method the location and exact amount of finish may be indicated on the drawing, and if pattern-makers are held to this, the excess metal can be reduced to a minimum, and no small item of expense saved, both in material and labor.

Detroit, Mich. J. C. AUSTIN.

THE FOUR-CYLINDER BALANCED COMPOUND.

To the Editor:

While the results of the tests of the four-cylinder balanced compound locomotives at St. Louis indicated an efficiency and economy of this type over all others, a majority of motive power men seem to hesitate in their acceptance of the facts before a very long consideration of the new conditions to be met with in operation and maintenance in actual service. Imaginary "compound" difficulties, twisted crank axles and other bogies seem to threaten them with an increased "cost per mile," and a prejudice is apparently created which as yet the engines have had no chance to earn!

The objections, however, in some cases are well founded on some unsuccessful and costly experiments with certain types of compounds which were wholly unsuited to the conditions surrounding them and the services required. This may account for the apparent lack of interest in practical results obtained from the application of what is conceded to be an excellent principle. Notwithstanding the fact that a great many roads have been experimenting with some particular type of four-cylinder balanced compound, there has been very little written upon this important subject bearing on the relative economy or efficiency of these engines in regular service.

There would seem to be a great deal of significance attached to the fact that the Oregon Railroad & Navigation Company, after several months' trial of a heavy Pacific type balanced compound in passenger service, has ordered a lot of simple engines of nearly the same specifications.

On the other hand, the Santa Fe, a road which operates under the most widely diversified conditions known, has more than a hundred four-cylinder balanced compounds in the most exacting passenger service, and each succeeding locomotive order includes more of the latter type.

The writer believes that he is only one of a great many who would appreciate some light on this very interesting and timely subject, whether it be a general review and criticism or simply a comparison of results from the operation of these engines in regular service.

Minneapolis, Minn. J. P. R.

RIEGEL WATER TUBE BOILER.

To the Editor:

Referring to the criticisms of the water tube boiler in your May issue. In view of the exceptions taken in the communications to the circulating baffling sheet, placed 30 ins. ahead of the tube sheet of the boiler, as illustrated in your April issue, perhaps a little explanation setting forth the reasons for its introduction would put more light on the subject.

To begin with, the baffling sheet is not a necessity, nor really a part of this design in particular. It was introduced into the design to overcome flue leakage in rear tube sheet. There are those who believe flue troubles are due to the furnace flames impinging directly against the flue ends, causing them to become highly heated and consequently expanded, which, when quickly cooled by an inrush of cold water, causes a rapid contraction of the firebox ends of the tubes submerged in the cold currents and makes them leak. By the introduction of the extra firebox surface in the new design the flue surface can be reduced; thus be kept away from the barrel; a smaller number of flues, with a wider bridge, being justified. The dam sheet is proposed to be used under these conditions. It will be noted, in the description it is stated "the necessary flue holes in this dam are not a tight fit to the flues." i. e., the holes are to be sufficiently large to allow a moderate amount of water to flow through all of the flue holes between the flues and the sheet. The object of the plate being to baffle or retard the cold currents and keep them away from the flue ends until they can become warmed above the danger point. With the water tube arrangement the circulation about the firebox will be so vigorous as to excite all of the water to circulation. As the head creating the circulation will be the upward currents through the water tubes, which, in the design, is due to the heat effect on a

surface of 538 sq. ft. against the balance of 230 sq ft. of firebox surface, or approximately a pull of 538 units against a resistance of 230 units. This has a tendency to draw the water from the water legs and the barrel of the boiler into the water pockets. The water would have to both flow over and leak through the dam sheet. The forward part would thus provide a thermal storage chamber within the boiler itself.

Incrustation of the water tubes of course depends upon the water used, but it is not as much as might be inferred by some. From actual service records of engines with cross-water tubes on the London & Southwestern Railway, England, from a water, on a greater part of the system, having a total hardness of 16 grams per gallon, yielding a very heavy deposit, the tubes are only cleaned when the engines come to the shops for general repairs at intervals of eighteen months or so. In this time the mean deposit does not exceed 1/32 in.

The average life of a tube depends upon its position in the group. Those in the outside rows in express engines built between 1899 and 1901 have a life varying from two and a half to five years, the short period being due to manufacturers' defects developing.

S. S. RIEGEL,
Southern Railway Company.

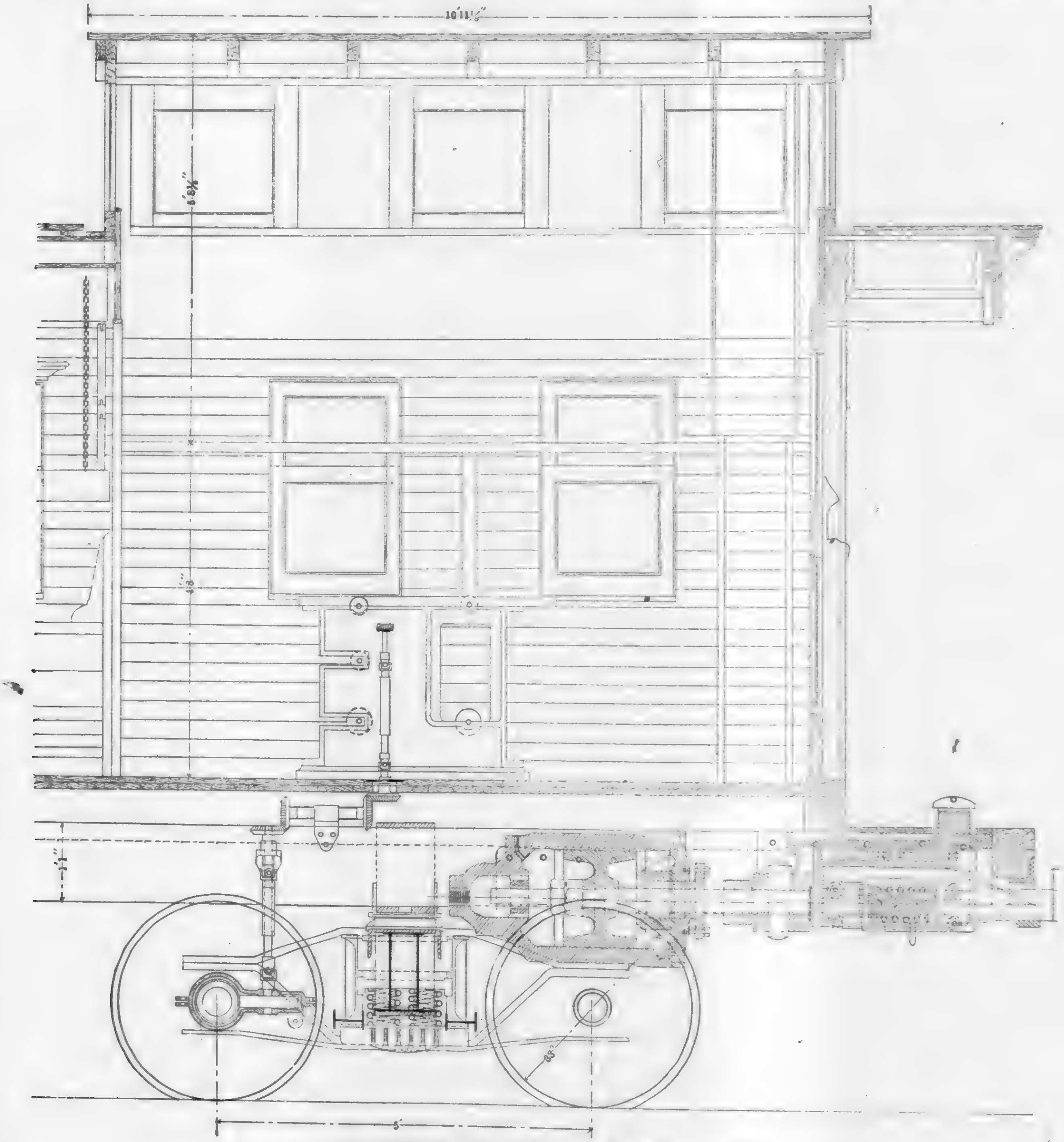
1300 Pennsylvania Avenue,
Washington, D. C.

DYNAMOMETER CAR.

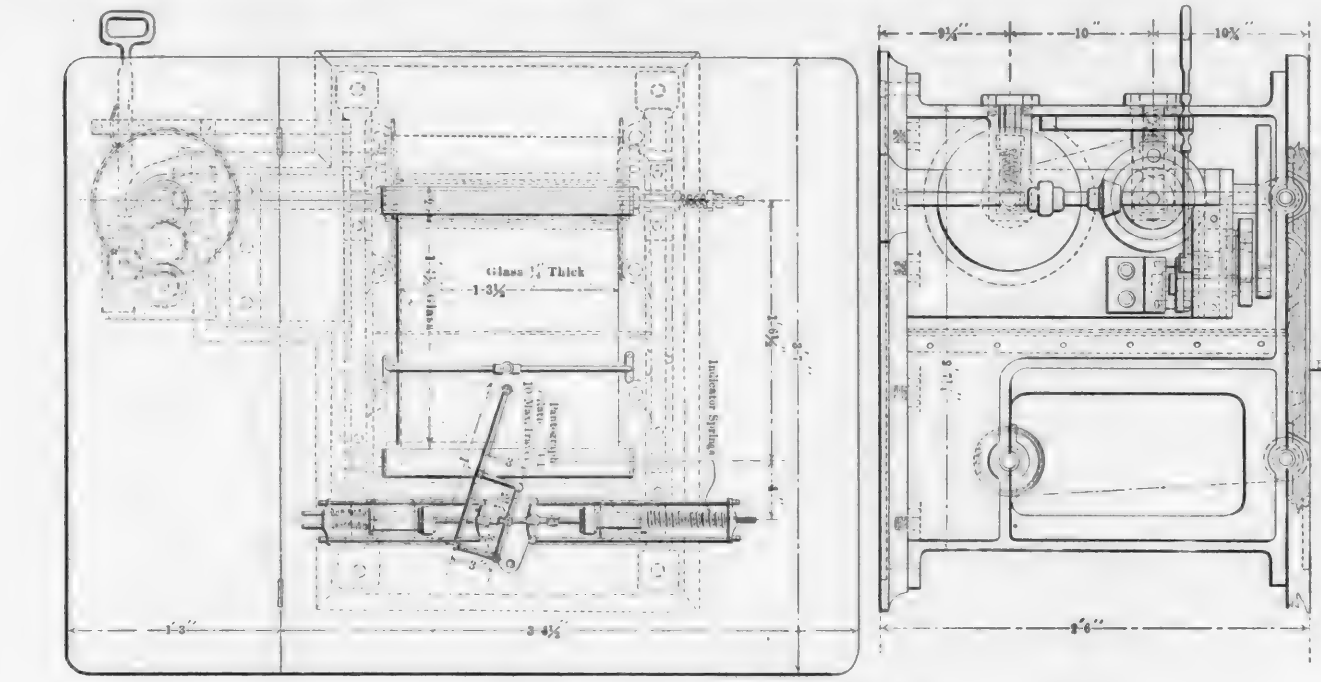
CANADIAN PACIFIC RAILWAY.

The Canadian Pacific Railway has recently built a dynamometer car at the Angus shops which is of special interest because of the arrangement for transmitting force from the drawbar to the hydraulic cylinder, and also because of the method of operating the recording pen. The construction of the car, except for the underframing, is similar to the standard caboose used on this road. The center sills are 13-in. channels, 37 lbs. per ft., spaced 26 ins. apart. Above each channel and between it and the floor is a 4¼-in. wooden sill 6 ins. deep. The intermediate and side sills are 5 by 9 ins. The inside dimensions of the car are: length, 28 ft. 6⅝ ins.; width, 8 ft. 6⅝ ins. In addition to the space 10 ft. long at one end of the car, which contains the dynamometer table, there are two sets of upper and lower berths, a kitchen, pantry, clothes closet, heater room and saloon. The rear end of the car is equipped with Miner tandem spring draft rigging.

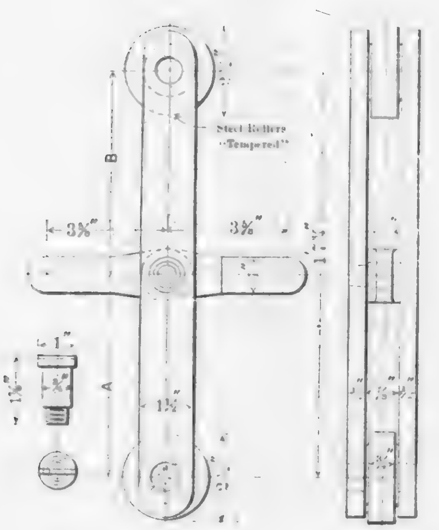
The drawbar at the dynamometer end of the car is of the



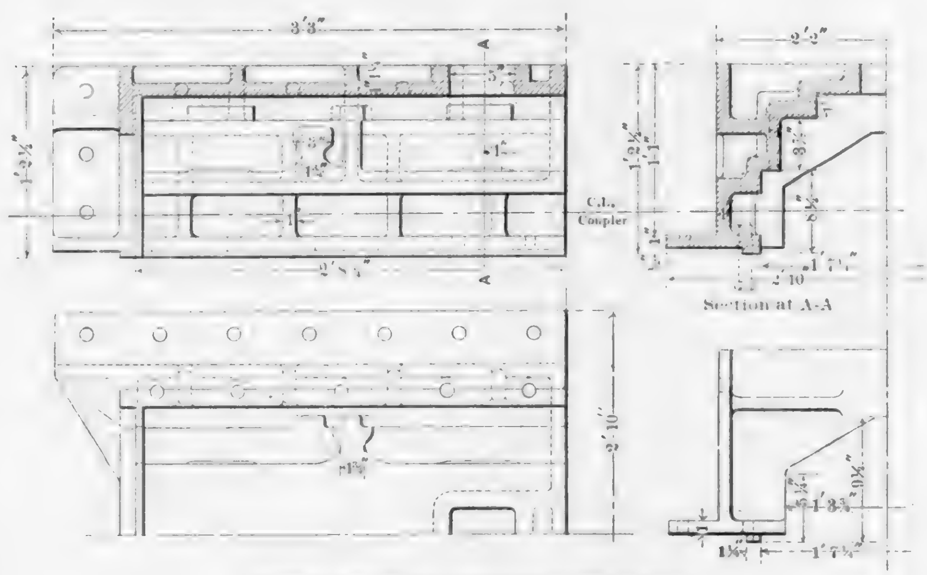
DYNAMOMETER CAR.—CANADIAN PACIFIC RAILWAY.



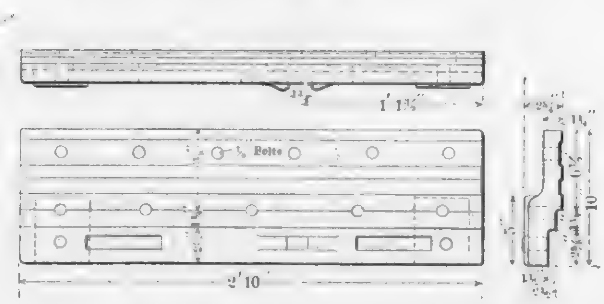
RECORDING MECHANISM.—DYNAMOMETER CAR.



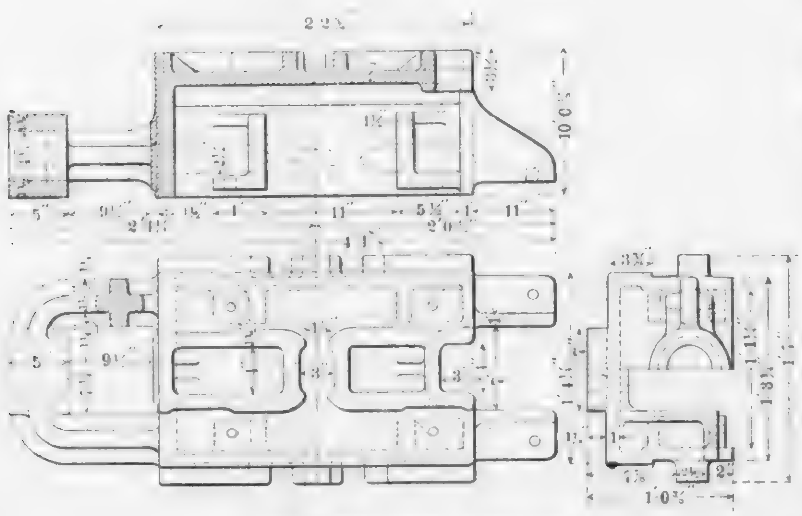
ROLLER BEARINGS FOR CRADLE.



STEEL CASTING IN WHICH CRADLE SLIDES.



CAST IRON GUIDES OR BOTTOM SLIDES.



CAST STEEL CRADLE CASTING.

standard type, and is equipped with an ordinary twin spring draft rigging. The follower plates of the draft rigging fit between lugs on a cast steel cradle casting, which is shown in detail in one of the illustrations. The cradle casting is connected to the dynamometer piston rod and slides in a heavy steel casting, which is securely bolted to the center sills. To reduce the friction to a minimum six roller bearings, of the Susemihl type, are interposed between the two castings, as

shown on the general drawing. Cast iron guides, or bottom slides, are bolted to the large steel casting and support the cradle casting at the bottom. At the rear end of the cradle casting is a heavy loop or projection. The dynamometer piston rod, 4 ins. in diameter, passes through a 4¼-in. hole in this projection, and is held in place by a large collar, to which it is keyed as shown in the drawing. The coupler carrier iron is bolted to two projections at the other end of the cradle casting. At any time that it is advisable to relieve the pressure on the dynamometer cylinder it is only necessary to force the oil out of the rear end and push the cradle casting back until it comes in contact with the rear end of the large casting, in which it slides, and drop into place the key which is shown projecting above the platform. The cradle will then be held rigidly and the draft rigging will operate the same as on an ordinary car.

The hydraulic cylinder is 16 ins. inside diameter and the walls are 2¾ ins. thick. It is bolted to the center sill by 20 one-inch bolts. The piston and cylinder are designed for a working pressure of 500 lbs. per sq. in. Each end of the cylinder is connected to the cylinders of the recording mechanism by ⅜-in. wrought iron pipe. A hand pump is provided to adjust the piston if it should get out of its central position.

Motion is transmitted from the axle to the paper driving mechanism by means of a worm, which is clamped to the axle and drives a worm wheel connected by the flexible shaft to a train of bevel and spur gears. By means of a lever at one corner of the table the paper may be operated at any one of three speeds, 6, 12, and 60 ins. per mile. The frame of the table is of a heavy cast iron design, making it very rigid.

The pen has a maximum travel of 10 ins., 5 ins. either side of the center line, and is controlled by a pantagraph motion with a ratio of 4 to 1. For registering the drawbar tension the pen is adjusted for 10,000 lbs. per in. As these stresses are the smaller and more important ones, the indicator springs are placed in tandem, as shown, so that with an ordinary drawbar pull the pen has a considerable movement. For the buffing strains, which are ordinarily very much higher, and which need not be registered so accurately, a twin arrangement of indicator springs is used, as shown. This car was designed under the direction of Mr. H. H. Vaughan, assistant to the vice-president, by Mr. A. W. Horsey, mechanical engineer.

RAILROAD Y. M. C. A.—A new Railroad Y. M. C. A. building, which cost $32,000, was opened at Collinwood, Ohio, L. S. & M. S. Ry., on May 1. Mr. W. C. Brown, vice-president of the New York Central Lines, at the close of an interesting address at the opening exercises, made the following statement: "The railroad which annually draws thousands of young men from the villages and farms to fill up its ranks, depleted by age, accident and disease, owes something to this army of young men. They owe it to the men themselves; they owe it to anxious, loving fathers and mothers back in the homes from whence these young men came; above all, they owe it to the public who daily place in the care and custody of these men their lives and property, to do everything within their power to make them the best, safest, most efficient men possible; and in doing this, in my opinion, no agency can be enlisted so adapted, so consecrated, so devoted to the work, and so successful in the work, as the railroad branch of the Young Men's Christian Association."

THREE-CYLINDER BALANCED COMPOUND LOCOMOTIVE.—For steam locomotives the merits of a three-cylinder balanced compound type, with one high-pressure inclined cylinder between the frames and a low-pressure cylinder at each side outside the frames; having the high and low-pressure cylinders connected by ordinary pistons, crossheads and main rods with the main driver axles and wheels, with cranks at 120 deg., and using a combined receiver and intermediate superheater for the passage of the exhaust steam between the high and low-pressure cylinders, should be investigated for passenger and fast freight service.—*Mr. Muhlfeld, New York Railroad Club.*

TEST OF THE WESTINGHOUSE CROSS COMPOUND AIR PUMP.

The continually increasing demands upon locomotive air pumps are apparent to all railroad men and have on larger locomotives, both passenger and freight, reached a stage where the pump is in almost constant operation with results which show not only in air-pump failures and repairs, but also have an appreciable effect upon the coal pile. In the past, features connected with capacity, weight and size of air pumps have been considered to be of greater importance than economy of operation and the improvements have all been along those lines.

Recognizing that the development of these devices has reached a stage where, while the previous considerations still deserve most careful study, the matter of economy of operation must also be included, the Westinghouse Air Brake Company has recently perfected a cross compound locomotive air pump which uses steam in compound cylinders connected to compound cylinders for the compression of air. While this arrangement doubles the number of cylinders over the previous designs built by this company, and occupies considerable more space as well as giving an increase in weight, recent careful tests of the pump show that its largely increased economy more than makes up for all of these disadvantages. The present design of this new pump uses an 8½ by 12-in. high-pressure steam cylinder located above and connecting to a 14½ by 12-in. low-pressure air cylinder. The low-pressure steam cylinder, which is 14½ by 12, connects to a 9 by 12 high-pressure air cylinder. The whole device is made as compact as possible, and considering its capacity it occupies but little more room than the simple pump.

In order to determine exactly what this new design would accomplish, a most careful test of it was made in comparison with what was considered to be the most efficient air pump at present on the market. This test was made under conditions which allowed accurate observations to be taken and gave results which are most gratifying from every standpoint. The series of tests made were all for the purpose of determining the efficiency and capacity and were made under several different conditions, first with the pumps working against a constant air pressure with different steam pressures; second, with the pumps working against constantly increasing air pressure, and third, with the pumps working against an orifice in a diaphragm at an approximately constant pressure. The table below gives some of the more interesting results obtained, which in all cases are a large improvement over the work of any locomotive air pump previously designed. A complete report of the test which was made under the direction of the motive power officials of the Lake Shore & Michigan Southern Railway at the Collinwood shops may be obtained from the Westinghouse Air Brake Company, Pittsburg, Pa.

AGAINST A CONSTANT AIR PRESSURE.

Steam pressure	200	200	200	200
Constant air pressure	140	130	100	70
Duration of test (min. and sec.)	5-46.4	4-41.8	4-07.6	3-11
Cubic feet free air pumped per min	115.5	131	151.6	168
Steam per 100 cu. ft. free air—lbs.	21.5	19.7	18.6	17.7
Volumetric efficiency, per cent.	82.1	88.2	89.7	90.7

AGAINST A CONSTANTLY INCREASING PRESSURE.

Steam pressure	200	200	200	200
Initial air pressure	30	30	30	30
Final air pressure	70	100	130	140
Cubic feet free air pumped	98.9	173.1	247.3	272
Weight of steam used, lbs	21	36.3	51.8	57.5
Time (min. and sec.)	0-39.8	1-12.4	1-47.6	1-59.2
Per 100 cu. ft. F. A. from initial to final pressure. Time, sec.	40.2	41.8	43.5	43.8
Per 100 cu. ft. F. A. from initial to final pressure. Steam, lbs.	21.2	20.9	20.9	21.1

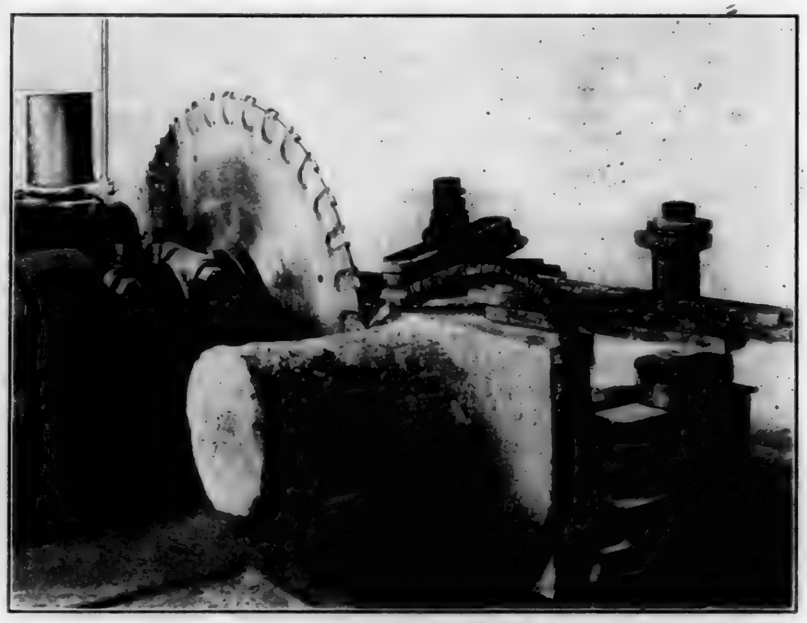
The pump also held an average pressure of 119 lbs., with 200 lbs. steam pressure, against a 17/64-in. orifice for 2 minutes, using 25.6 lbs. of steam per minute.

In the temperature test it held a pressure of 100 lbs. for 20 minutes, giving temperatures at the pump discharge gradually increasing from 340 degs. at the start to 505 at the finish, and in the reservoir of 210 degs. at the start and 280 at the finish.

THE TAYLOR NEWBOLD SAW.

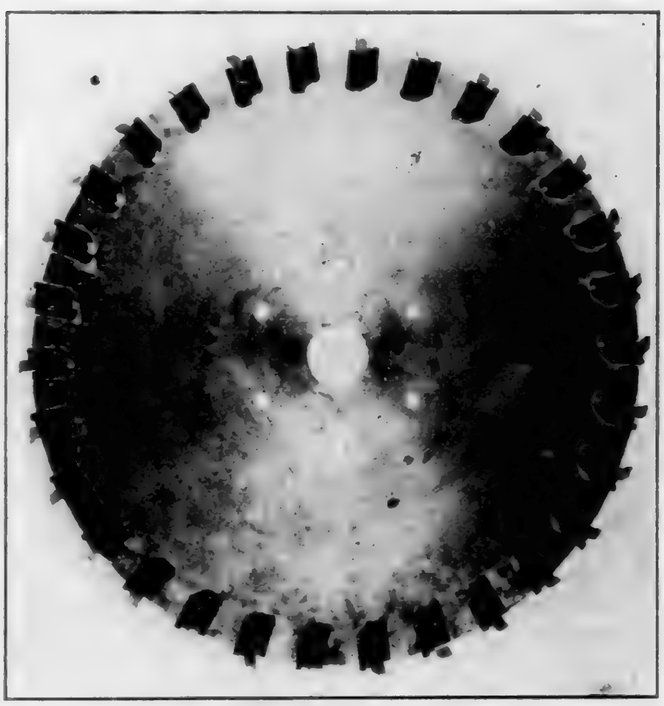
The Taylor-Newbold saw has been developed during the past few years to meet the demand for a high-speed metal saw with a maximum cutting strength and a maximum resistance to abrasion. As may be seen from the illustrations, it consists of a heavy steel disc fitted at the periphery with a number of high-speed tools similar in shape to those used on a planer or lathe. It is thus possible to use a comparatively heavy feed, and the chips resemble those produced by a machine tool rather than the fine cuttings or dust produced by the ordinary type of metal saw. The total amount of power required to cut through a given piece of material is thus reduced, and there is very much less tendency to wear the teeth. The saw is specially valuable for cutting castings, as the depth of the cut is such that the teeth get under the scale or the hard surface, and are not ground away by the grit or sand, as is the case when a finer feed is used. The inserted teeth are so designed that they may be broken repeatedly without damage to the saw disc, and a broken tooth can be replaced easily and quickly without removing the blade from the machine.

A BROKEN TOOL OR TOOTH.



CUTTING A HEAVY RISER ON A STEEL CASTING.

The steel disc is somewhat thicker than an ordinary saw blade, and has an even number of pockets milled about the circumference. These pockets are provided with tongues to hold the inserted teeth laterally, and the bottoms of the pockets are very accurately milled to the same distance from the center of the saw. The teeth consist of U-shaped holders, in which the cutters are inserted and held by casting type metal about them in such a way that each cutter has a solid steel bearing behind it, while the space in front, which is subjected to the least pressure, is filled with the soft metal. The holders are provided with set screws, by which the height of the cutters may be adjusted. At the back of each holder a wedge is driven to hold it securely in place. The teeth are alternately broad and narrow, the narrower teeth being set out further than the wide ones, so as to divide the cutting about evenly between the two sets.



THE TAYLOR-NEWBOLD SAW.

A special gauge is provided, by which the teeth can be adjusted to a uniform height ready for insertion in the saw, and when a change of teeth is necessary the time required will be simply that necessary for knocking out the wedges, removing the old teeth and inserting the new ones. It is thus possible to keep the saw in practically continuous service. The cutters are of unusual depth and strength, have sufficient metal to provide for a large number of grindings, and are made of the best grade of high-speed steel treated by the Taylor-White process. It should be noted that there are two pieces of metal between the cutter and the blade, so that the breaking of the cutter will not destroy the blade. The cutter simply mashes the soft holder, as shown in one of the illustrations. The set screw in the base of the holder is made of hard brass or bronze, which will also crush, thus relieving the blade from pressure in a radial direction. When a cutter is broken the holder is immediately removed and a new cutter inserted with very little delay.

An instance is recorded of a 40-in. saw of this type which ran continuously cutting steel castings for three months without regrinding. Such usage is not to be advocated, as better results may be obtained if the saws are ground regularly, but it will serve to give some idea of the capacity and durability of the saw. The very heavy cutting pressure upon each tooth requires special precautions for holding the work. Unless this is done, the work will slip and the saw will buckle.

ONE OF THE TOOLS AND WEDGE.

These saws were first developed for cutting armor plate at

100,000-LB. HART CONVERTIBLE CAR.—BALTIMORE & OHIO RAILROAD.

the plant of the Bethlehem Steel Company. They are used quite largely in steel foundries, forging shops, structural works and rail mills. The writer recently saw one cutting off the ends of cast iron driving box shoes in a large railroad shop, and was advised that they would easily cut off considerably more than 150 of these without resharpening. The saw which was formerly used was of the ordinary type, and after cutting off four shoes required regrinding. A special attachment is made for grinding the teeth accurately, which may be used with any wet emery grinder, or a grinder designed especially for this work is made by the Tabor Manufacturing Company of Philadelphia, manufacturers of the Taylor-Newbold saw.

MECHANICAL STOKERS FOR LOCOMOTIVES.—There is a great deal of benefit to be derived from their use. The fire is carried more uniformly all over the grate, better than can be maintained by hand firing; the contraction and expansion is less on the side sheets and flues, for the fire is bright all over the grate at all times and there is no air going into the firebox through the door, which I consider a great benefit. Engines have been run 900 miles without cleaning their fire, which could not have been done with hand firing.—*Mr. John W. Cool, Central Railway Club.*

50 TON HART CONVERTIBLE CAR.

BALTIMORE & OHIO RAILROAD.

The Baltimore & Ohio Railroad has recently received an order of 250 of the standard steel underframe 50-ton Hart convertible cars designed and built by the Rodgers Ballast Car Company.

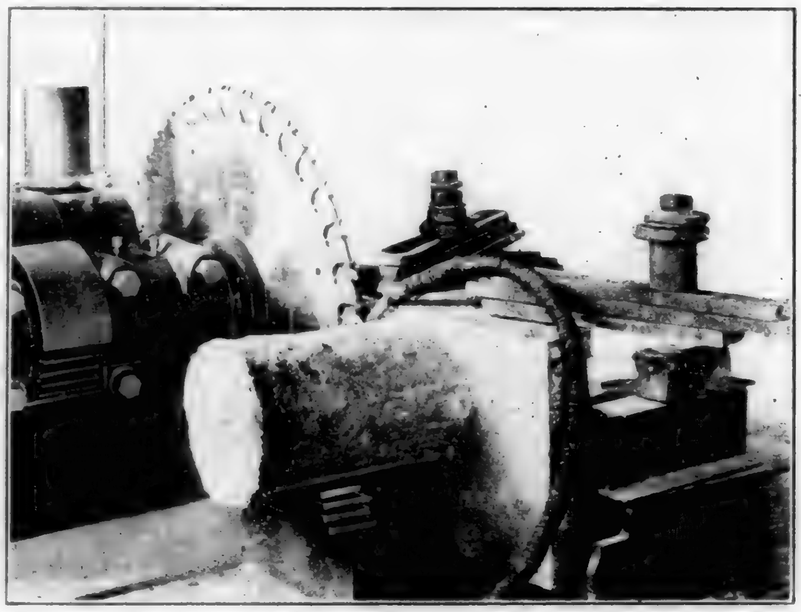
As may be seen in the illustration, these cars are convertible from a plain gondola to a center or side dump ballast car, being so constructed that the conversion from one to the other can be made in a short time, without the use of special tools, by unskilled labor.

The underframe is of heavy steel construction, the four sills being of the built up girder type, the two immediate ones in I section and the side sills in channel section, both having a deep web at the center and being securely tied together with plates and angles at different points. The space between the two immediate sills, between the bolsters, contains no longitudinal sills and is taken up by the hopper bottom, which remains permanently in place. The cross ties between the immediate sills, however, are carried across the hopper opening, as is shown in the view of the car as arranged for center dumping. The superstructure of the car

THE TAYLOR NEWBOLD SAW.

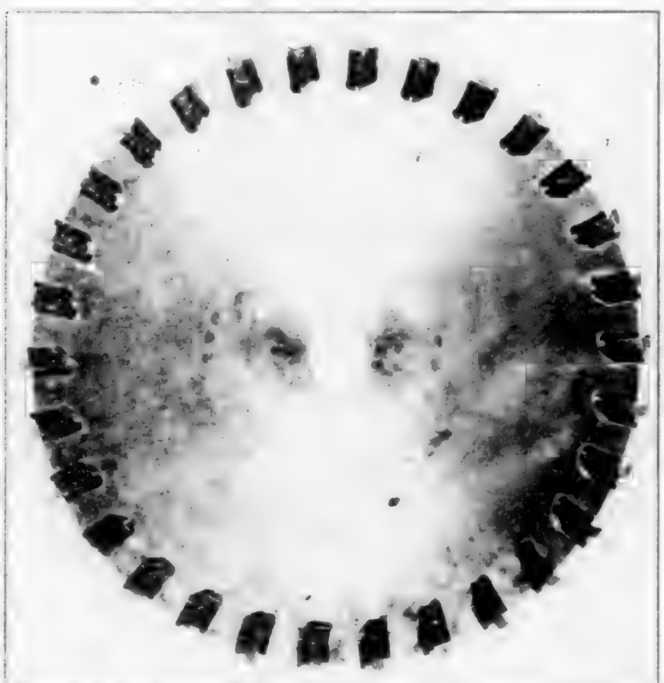
The Taylor-Newbold saw has been developed during the past few years to meet the demand for a high-speed metal saw with a maximum cutting strength and a maximum resistance to abrasion. As may be seen from the illustrations, it consists of a heavy steel disc fitted at the periphery with a number of high-speed tools similar in shape to those used on a planer or lathe. It is thus possible to use a comparatively heavy feed, and the chips resemble those produced by a machine tool rather than the fine cuttings or dust produced by the ordinary type of metal saw. The total amount of power required to cut through a given piece of material is thus reduced, and there is much less tendency to wear the teeth. The [illegible] specially valuable for cutting castings, as [illegible] the teeth go under the scale or the hard surface, and are not ground away by the grit or sand, as is the case when a finer feed is used. The inserted teeth are so designed that they may be broken repeatedly without damage to the saw disc, and a broken tooth can be replaced easily and quickly without removing the blade from the machine.

[illegible]



CUTTING A HEAVY RISER ON A STEEL CASTING.

The steel disc is somewhat thicker than an ordinary saw blade, and has an even number of pockets milled about the circumference. These pockets are provided with tongues to hold the inserted teeth laterally, and the bottoms of the pockets are very accurately milled to the same distance from the center of the saw. The teeth consist of U-shaped holders, in which the cutters are inserted and held by casting type metal about them in such a way that each cutter has a solid steel bearing behind it, while the space in front, which is subjected to the least pressure, is filled with the soft metal. The holders are provided with set screws, by which the height of the cutters may be adjusted. At the back of each holder a wedge is driven to hold it securely in place. The teeth are alternately broad and narrow, the narrower teeth being set out further than the wide ones, so as to divide the cutting about evenly between the two sets.



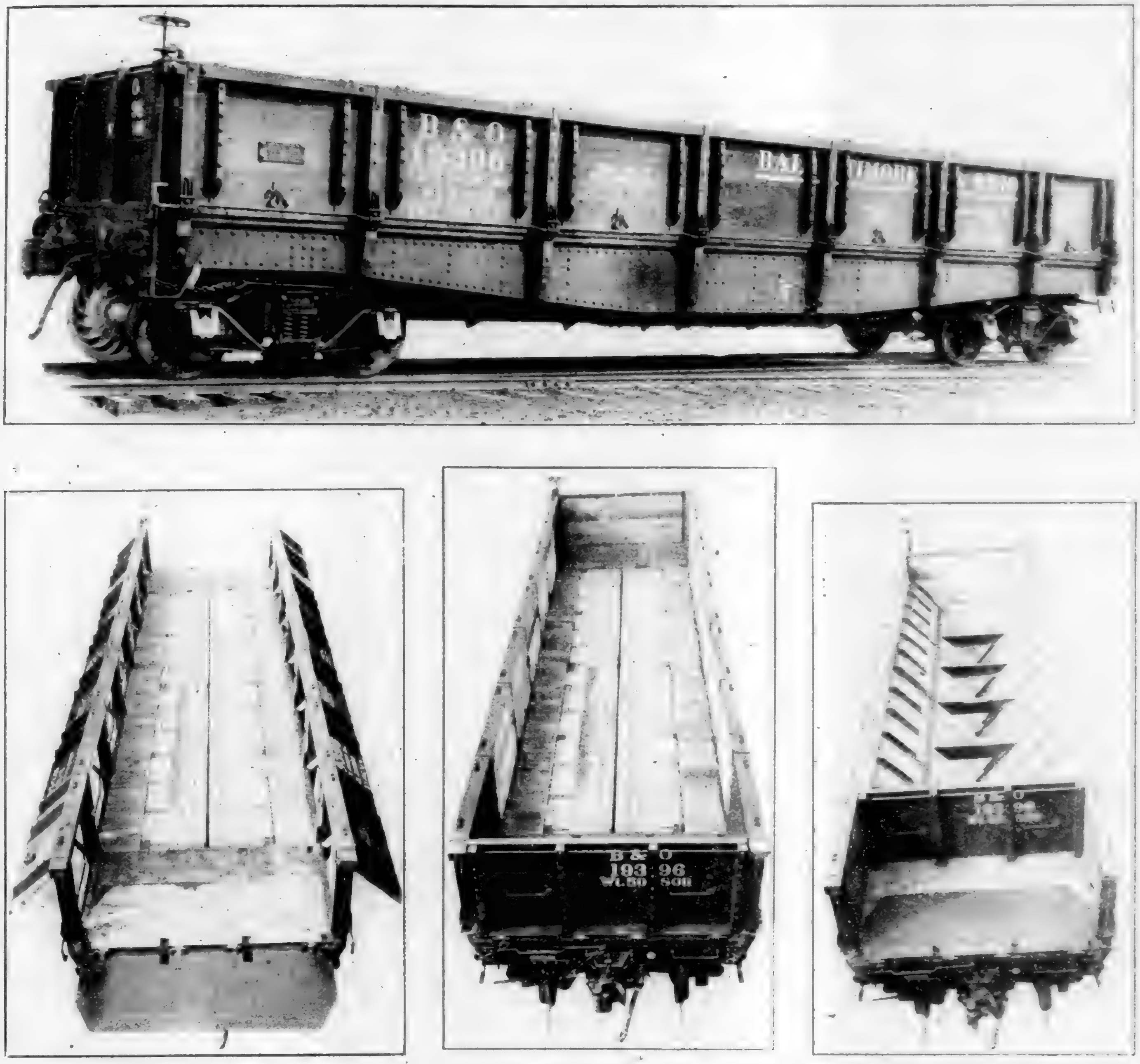
THE TAYLOR-NEWBOLD SAW.

A special gauge is provided, by which the teeth can be adjusted to a uniform height ready for insertion in the saw, and when a change of teeth is necessary the time required will be simply that necessary for knocking out the wedges, removing the old teeth and inserting the new ones. It is thus possible to keep the saw in practically continuous service. The cutters are of unusual depth and strength, have sufficient metal to provide for a large number of grindings, and are made of the best grade of high-speed steel treated by the Taylor-White process. It should be noted that there are two pieces of metal between the cutter and the blade, so that the breaking of the cutter will not destroy the blade. The cutter simply mashes the soft holder, as shown in one of the illustrations. The set screw in the base of the holder is made of hard brass or bronze, which will also crush, thus relieving the blade from pressure in a radial direction. When a cutter is broken the holder is immediately removed and a new cutter inserted with very little delay.

An instance is recorded of a 40-in. saw of this type which ran continuously cutting steel castings for three months without regrinding. Such usage is not to be advocated, as better results may be obtained if the saws are ground regularly, but it will serve to give some idea of the capacity and durability of the saw. The very heavy cutting pressure upon each tooth requires special precautions for holding the work. Unless this is done, the work will slip and the saw will buckle.

ONE OF THE TOOLS AND WEDGE.

These saws were first developed for cutting armor plate at



100,000-LB. HART CONVERTIBLE CAR.—BALTIMORE & OHIO RAILROAD.

the plant of the Bethlehem Steel Company. They are used quite largely in steel foundries, forging shops, structural works and rail mills. The writer recently saw one cutting off the ends of cast iron driving box shoes in a large railroad shop, and was advised that they would easily cut off considerably more than 150 of these without resharpening. The saw which was formerly used was of the ordinary type, and after cutting off four shoes required regrinding. A special attachment is made for grinding the teeth accurately, which may be used with any wet emery grinder, or a grinder designed especially for this work is made by the Tabor Manufacturing Company of Philadelphia, manufacturers of the Taylor-Newbold saw.

MECHANICAL STOKERS FOR LOCOMOTIVES.—There is a great deal of benefit to be derived from their use. The fire is carried more uniformly all over the grate, better than can be maintained by hand firing; the contraction and expansion is less on the side sheets and flues, for the fire is bright all over the grate at all times and there is no air going into the firebox through the door, which I consider a great benefit. Engines have been run 900 miles without cleaning their fire, which could not have been done with hand firing.—*Mr. John W. Cool, Central Railway Club.*

50 TON HART CONVERTIBLE CAR.

BALTIMORE & OHIO RAILROAD.

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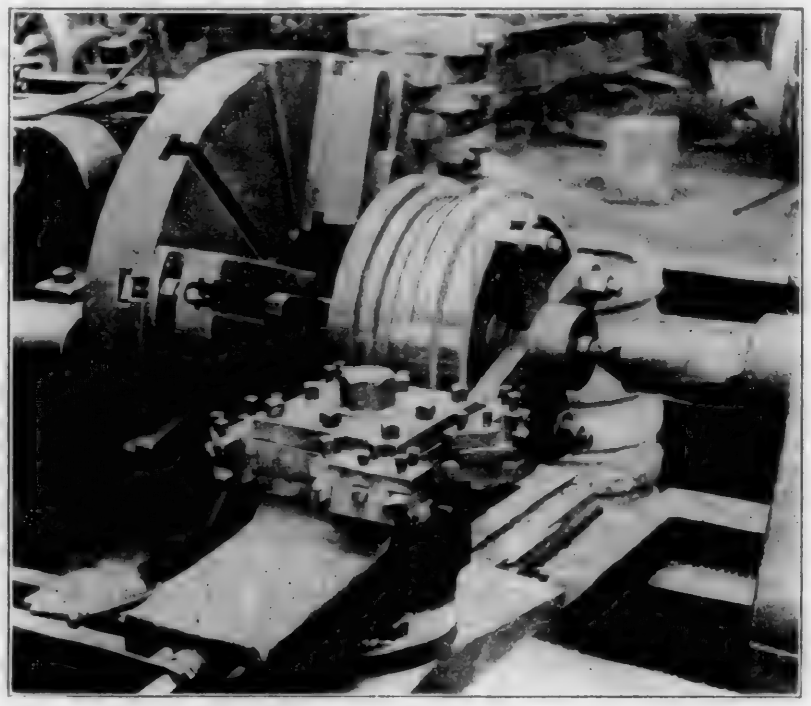
is of wood, the sides consisting of large posts and a heavy rail along the top of the posts, fastened to the steel side sills in a secure manner. The space between the posts is filled with the doors, which are hinged at the top and swing in flush with the top of the floor. These doors are securely fastened when closed by a simple design of lock, clearly shown in the side elevation. When the car is to be used as a side dump car the doors can be quickly and easily unlocked and swing outward on both sides.

When the car is to be used as an ordinary gondola the removable ends are placed in their position at the extreme end of the car; the bottom extension of the posts fitting into cast iron sockets set flush with the floor, and the top being secured by a tie rod through the side rails and the posts of the end door. The hopper in the center is covered by the swinging sections of the floor, and the car is, in fact, as well as in name, a gondola car. When it is desired to use it as a center dump car the ends are moved forward to a point just ahead of the bolster; the swinging sections of the floor over the hopper are swung upward against the sides, there being a recess arranged so that they form a continuous surface with the sides and down into the hopper. The dumping is regulated by one operator by a lever at the end of the car which permits him to either completely release the doors dumping the whole load at once, or partially opening them so that the material can be discharged gradually. The car as arranged in this manner will carry 1,200 cu. ft. or 110,000 lbs. of ballasting material, and will entirely clear itself of the load when the hopper doors are opened.

When it is desired to use the car with an unloader or as a side dump car the ends are removed entirely and the swinging section of the floor is swung down over the hopper. The permanent aprons at the end of the car are swung out over the ends of the adjoining car, thus forming a continuous platform throughout the entire length of the train, allowing material to be ploughed to either one or both sides. As a side dump construction car the capacity is 60 cu. yds. of material. As a gondola car it has an inside length of 40 ft. and a width of 8 ft. 8 ins., and will carry 1,600 cu. ft. The average weight of a car of this type is about 45,000 lbs.

TURNING BRASS ECCENTRIC STRAP LINERS.

The illustration shows the method of turning brass eccentric strap liners on a heavy Pond lathe at the Collinwood shops of the Lake Shore & Michigan Southern Railway. The liner is of a T section and is held on a cast-iron chuck with steps to take the various diameters and with corresponding steps on the lower or arbor portion of the chuck to receive the slotted clamps. The ring or liner is held to the chuck by four studs and clamps, the setting of which is expedited by the use of a ratchet wrench. Four sets of tools are held in the square turret, as shown. The first operation consists in roughing off the two diameters, i. e., the tongue and the two



TURNING BRASS ECCENTRIC STRAP LINERS.

sides. After the tools are properly adjusted a line is scribed on the lathe carriage and the operator is thus able to make his various adjustments for both the finishing and the roughing cuts without the use of calipers. The three tools in each set make it necessary for the carriage to travel a distance only one-third the width of the liner. After the two diameters of the liner are roughed off the sides of the tongue are roughed out; for the third operation the liner is turned to the proper diameter, and in the fourth and last operation the tongue is finished to the proper width. This tool has effected a saving of 80 per cent. over former methods. We are indebted for information to Mr. M. D. Franey, superintendent of the shops.

BURLINGTON ASSOCIATION OF OPERATING OFFICERS

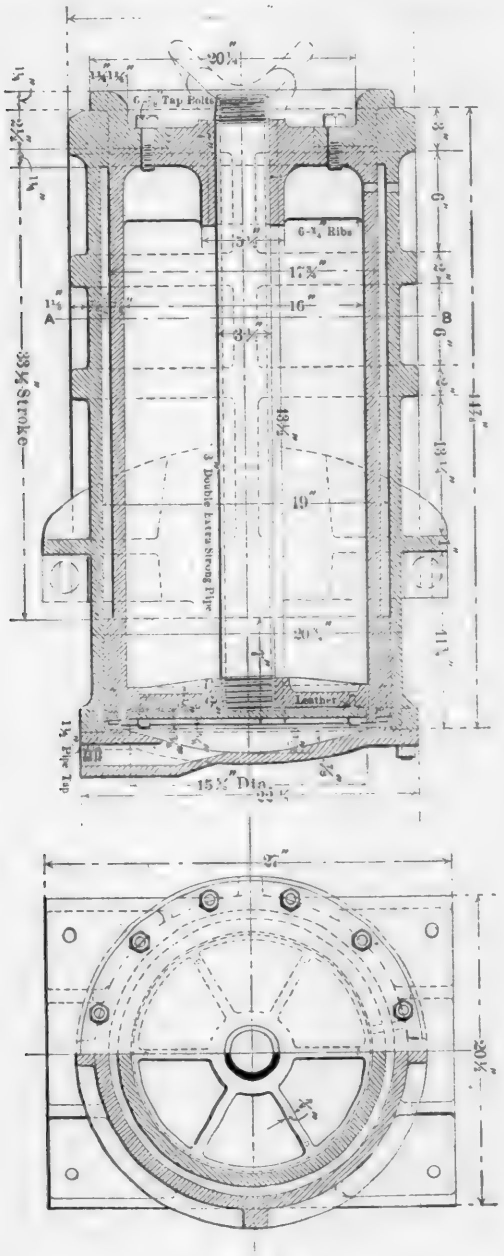
On a large railroad system the importance of periodically calling together the various officers of the operating departments to discuss the problems pertaining to their work cannot be overestimated, and it is surprising that it is not more generally done. This is true if the officers of each department meet by themselves, or more especially, if the officers of all the departments meet together and discuss problems which are common to all. A general organization such as the latter, and known as the Burlington Association of Operating Officers, has been in existence on the Chicago, Burlington & Quincy Railway for some time, and is the outgrowth of a department organization formed 20 years ago. On March 10th, 1886, the master mechanics of the Chicago, Burlington & Quincy and System Lines met at Aurora, Ill., and organized a master mechanics' association with a membership of 15 to 20. Mr. G. W. Rhodes, then superintendent of motive power, was elected chairman, and served in that capacity until 1903. The meetings were held semi-annually until 1898, and since then annually. The object of the organization was the discussion of questions of mechanical detail and the establishing of standards and practices pertaining to the motive power department.

From the very first the members took a considerable interest in the meetings, as did also a number of the other officials. In November, 1896, the superintendents first met in joint session with the master mechanics, and they also organized a superintendents' association. From that time until 1902 meetings were held jointly and separately by both these associations. In March, 1903, the two associations were consolidated, and the Burlington Association of Operating Officers was organized with a regular constitution and by-laws. The officers of this association consist of a chairman, a first and second vice-chairman and a secretary, who perform the duties usually devolving upon such officers. The executive committee is composed of the chairman, and the vice-chairmen of the association, together with the general managers of the Lines East and West or representatives annually appointed by them. This committee selects the subjects which appear to be of more general interest from those which the members have been invited to hand in, and the members are notified by a printed program of all new subjects introduced for discussion at least three weeks prior to the time of meeting. They decide on the time and place of all meetings, and have general

charge of the affairs of the association.

Altogether 38 meetings have been held, and 16 different points on the line have been visited, among them Chicago, Aurora, Omaha, Kansas City, St. Louis, Denver, St. Paul and others.

A regular order of business is followed at the meetings, and they are conducted in about the same way as those of the Master Car Builders' and American Railway Master Mechanics' Associations. Fifteen members, including the chairman, constitute a quorum for the transaction of business. The membership of the association consists of the general officers of the system and the following representatives from the Lines East and West. General managers, general superintendents, assistant general superintendents, superintendents of divisions and terminals, assistant superintendents of divisions and terminals, chief engineers, engineer Lines East and West, engineers maintenance of way, superintendents of



TELESCOPIC PNEUMATIC JACK.—L. S. & M. S. RY.

motive power, mechanical engineers, engineers of tests, superintendents of shops, master mechanics of divisions and terminals, assistant master mechanics of divisions and terminals, general piece work inspectors, mechanical inspectors, inspectors of transportation, supply agents and auditors. Officials of the various departments not eligible for membership may be present at any meetings of the association upon invitation of the head of their department or of the executive committee, but do not take part in the proceedings unless invited by the chairman. The association has an active membership of about ninety at the present time.

Committees for the investigation of special subjects ordered by the association are appointed by the chairman, and serve until discharged by action of the association. There are also several standing committees, such as motive power statistics, motive power standards, train rules, permanent way, blanks, etc.

WHAT HAS BEEN ACCOMPLISHED.

Since the organization of the association in 1886 something over one thousand subjects have been considered. Nearly 60 per cent. of these have been submitted to the management, approved and made the standard practice of the road.

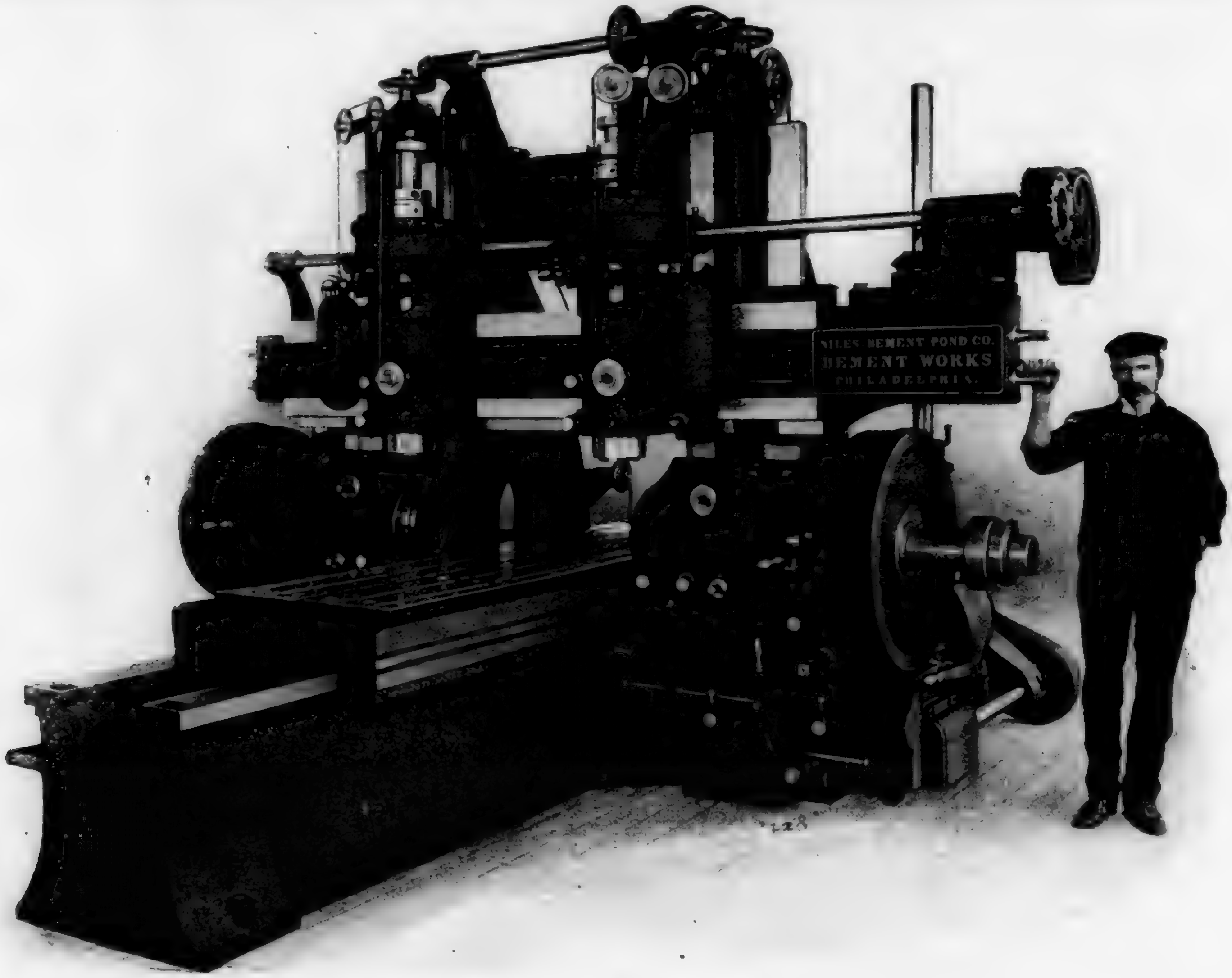
From a mechanical standpoint the association has been instrumental in bringing about a great many standards relating to rolling stock and other equipment of the road; it has tended to diffuse much information concerning new practice and ways of doing work between the different shops, thereby reducing the cost. It has created a lively interest and rivalry between the different divisions in the matter of economy and workmanship. One of the special aims of the association has been the co-operation of the different departments, the bringing together of superintendents, master mechanics and others and interesting them in each other's work through the discussion of subjects of mutual interest, such as the maintenance of permanent way, structures of all kinds, operation of trains, handling of freight, etc., which are of interest to master mechanics and superintendents alike. A concluding thought may well be expressed in the words of a former member. "I have very great faith in the efficiency of the workings of this joint association. I believe that in years to come the progress of the Burlington road will be written in the minutes of this association; the progress in economics; progress in improved methods; progress in all material things will be written in the minutes of these meetings." We are indebted for this information to Mr. S. D. Brown, secretary of the association.

TELESCOPIC PNEUMATIC JACK FOR DRIVING WHEEL DROP PITS.

The Lake Shore & Michigan Southern Railway has recently found it necessary to redesign its telescopic pneumatic jack used in connection with the driving wheel drop pits in the roundhouses. Upon the advent of the heavy Class J 41 Prairie type engines the jacks formerly used proved unsatisfactory, for the reason that the excessive weight of the wheels and axles (the weight of a pair of main drivers complete, including the centers, tires, axles, crank pins, driving boxes and eccentrics, is over 13,000 lbs.), and the height to which it is necessary to extend the jack (79-in. wheels), were such that unless it was placed exactly under the center of the axle the jack would become cocked in such a way as to lock it. When it gave way the force of the blow would break the cylinders and endanger the operator.

To overcome this the design was changed, with satisfactory results, to that shown in the illustration. The length of the bearings of the piston rod, piston and the two cylinders were increased considerably, so that when the jack was extended to its full height there would be no opportunity of its binding and sticking. The diameter of the inner cylinder was increased from 15 to 16 inches and of the outer one from 17½ to 19 ins. The various parts were strengthened, and the outer cylinder was ribbed, as shown. These jacks are supported by 3 by 3-in. wrought iron bars, which have journals at each end for 18-in. wheels equipped with roller bearings. We are indebted to Mr. R. B. Kendig, mechanical engineer, for drawings and information.

REMOVING A RUSTED SCREW.—Apply a red-hot iron to the top so as to heat it and immediately use screw-driver.—*American Machinist.*



BEMENT FOUR-HEAD MILLING MACHINE.

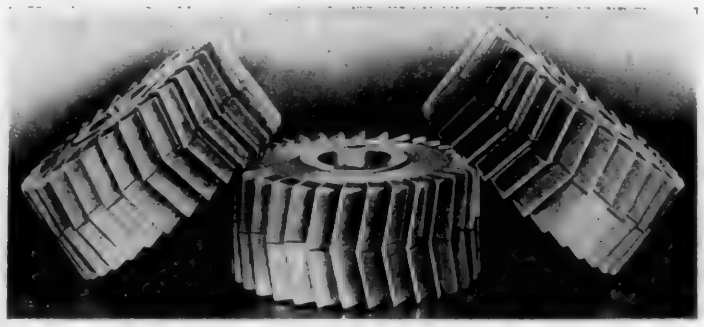
FOUR-HEAD MILLING MACHINE.

During the past few years the planer and vertical types of milling machines have rapidly come into general use in our railroad shops and are giving very satisfactory results. Interesting examples of work done by these two classes of machines will be found on pages 14, 32, 176, 228, 406, 409 and 449 of our 1905 volume, and on page 26 of our January, 1906, issue. The heavy milling machine is far superior to the planer for certain classes of work. In machining locomotive guides, for instance, where a good finish is desired, a roughing and a finishing cut are required on a planer, while only one cut is necessary with the milling machine and a better finish is obtained. By the use of gang cutters several surfaces may be machined at one time on the milling machine.

A combination of these two types, known as the four-head milling machine, and shown in the accompanying illustration, has all the advantages of the planer type miller and a number of the advantages of the vertical type machine, and should prove invaluable for use in the larger railroad shops, at least. An interesting description of the milling of locomotive side rods on a machine of this type, where all four cutters are used at the same time, will be found on page 24 of our January, 1906, issue.

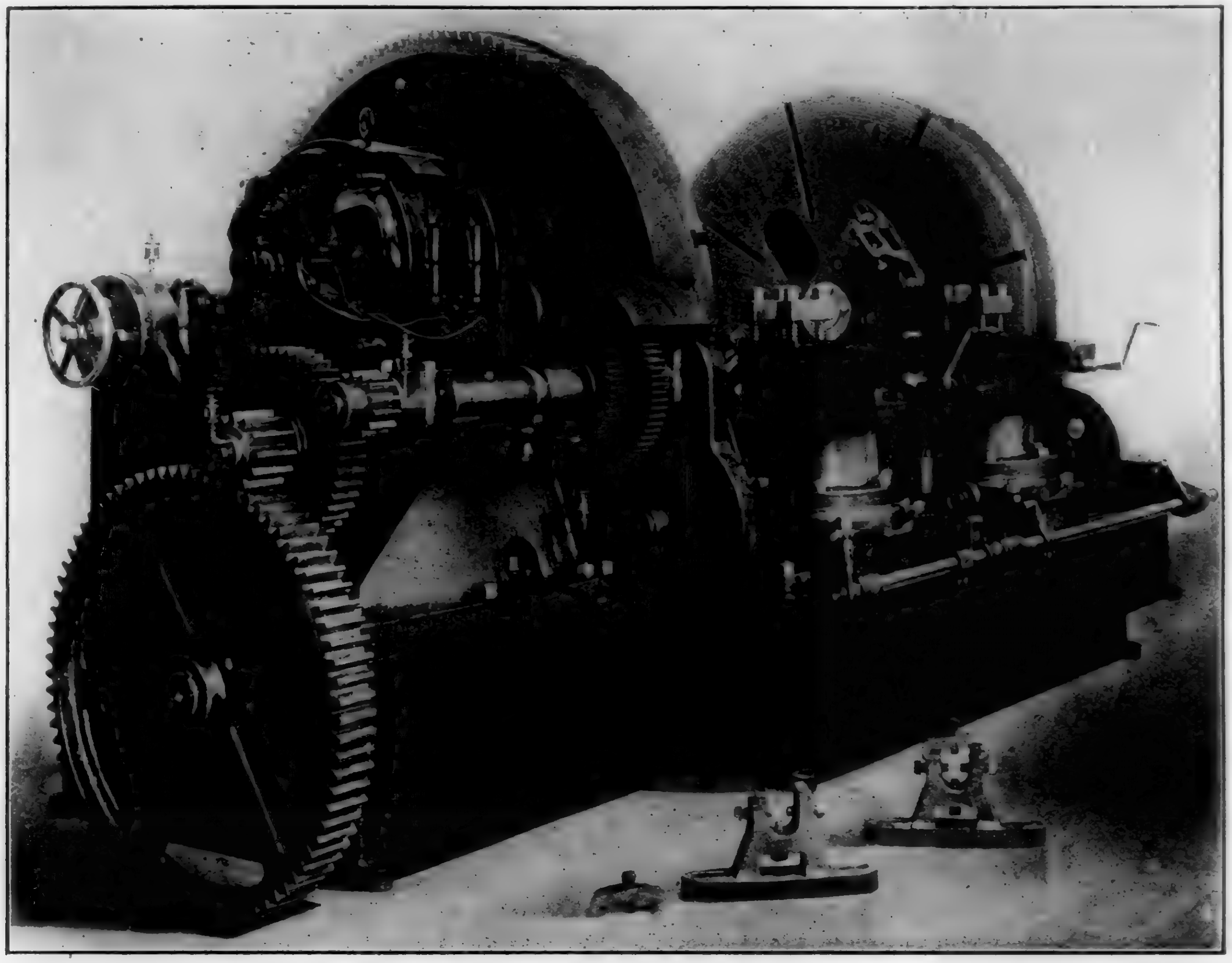
The variety of ways in which the various spindles may be used is almost endless. In milling castings the vertical spindles can be used to reach down and finish bosses, which are difficult to get at, at the same time that the horizontal spindles are machining the sides of the piece. The two horizontal spindles may be used for driving an arbor on which gang cutters are placed. One of the vertical spindles can be used to finish the end of a piece at one setting, the head being fed along the crossrail.

The machine illustrated is intended for work 36 ins. wide and 36 ins. high. The width between uprights is 43 ins. The table is 35 ins. wide and 8 ft. long, but the machine can be built to mill any desired length. The horizontal spindles have eight speeds, a maximum diameter of 8 ins., and a traverse of 10 ins. The maximum distance from the center of the horizontal spindles to the table is 30½ ins., minimum 4 ins. The maximum distance between the ends of the horizontal spindles is 43 ins. The maximum diameter of the vertical spindles is 6 ins.; traverse, 8 ins.; number of speeds, sixteen. The maximum distance from the ends of the vertical spindles to the table is 42 ins., minimum 8 ins. This machine is made at the Bement works of the Niles-Bement Pond Company.



INTERLOCKING MILLING CUTTERS.

One of the illustrations shows an interlocking milling cutter made by the Pratt & Whitney Company, which may be used



RIDGEWAY HEAVY 90-IN. DRIVING WHEEL LATHE.

for the channeling of locomotive rods, or for similar work where it is necessary to have a given width of groove and maintain a constant width of cut. The cutters are made in halves, the teeth of one-half interlocking with the other half. As the cutters are ground, washers can be placed between the two halves, thus keeping the width constant. This may also be accomplished with the inserted teeth cutters.

HEAVY 90-INCH DRIVING WHEEL LATHE.

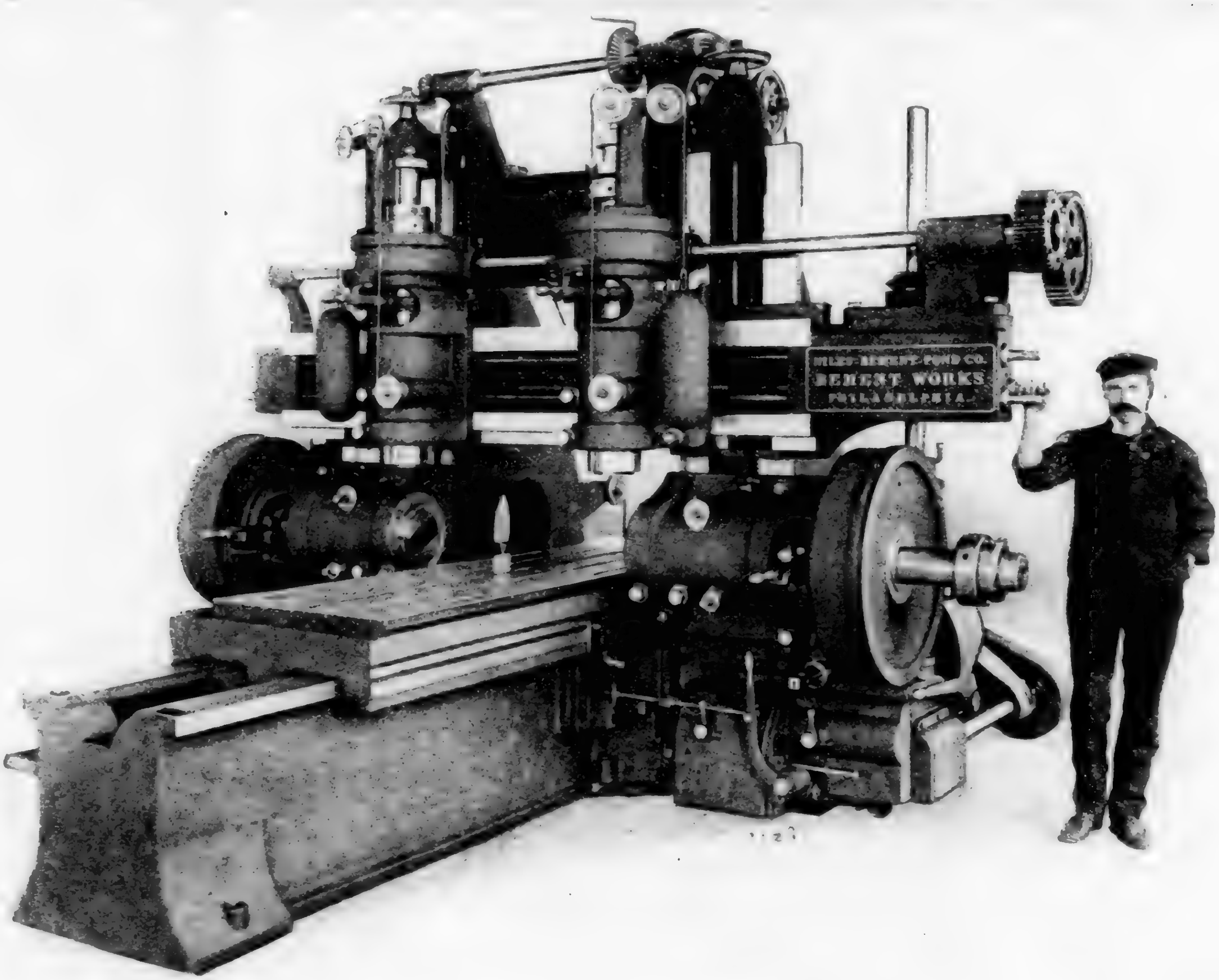
In a recent test the heavy 90-in. motor-driven Ridgeway driving wheel lathe, illustrated herewith, turned a badly worn pair of driving wheels, 57 ins. in diameter, in 59 minutes actual cutting time. The machine stood on the floor of the shop at the builders, and it was, therefore, impossible to force it to an extent that would have been possible if it had been set on its proper foundation. A ½-in. cut with a ⅛-in. feed was operated at a rate of 16 ft. per minute for the first 1½ ins. across the tread. The feed was then increased to ¼ in., shortly after which one of the high-speed tools gave out. Two other tools broke down before the cut was finished. The 59 minutes includes the time for replacing the tools. One hundred and eighty pounds of metal were removed, and the power consumed varied from 6 to 26 h.p. This machine was made by the Ridgeway Machine Tool Company, and was driven by a Thompson-Ryan variable speed motor having a speed range of 4 to 1.

The machine is of compact and substantial design, and the driving dogs and face plates are so designed that the wheels may be set very close to the face plates. The rests are arranged to give only a very slight overhang to the tools, and the bed is extended at the front in order to give a solid support for the rests. Recesses are arranged in the face plates for the crank pins, thus allowing the wheels to be brought close to the face plates. A small electric motor is attached to the tail stock, and is geared directly to a traversing screw for moving the head back and forth. One of the gears is arranged to slip at a certain point, so that it is possible to run the motor at full speed, bringing up the center at a rapid rate and avoiding the necessity of slowing down. The power of this device may be adjusted, so that the necessary force is applied to bring the center solidly into place, thus avoiding the necessity of adjusting the centers by means of a hand wheel.

The sides of the tool rests next to the face plates are cut away at the top and reinforced on the under side, in order to allow the driving dogs to be brought as near the rim of the wheel as possible. The tool blocks have swiveled compound slides, with power feed in any direction, and may be set to turn wheels from 48 to 90 ins. in diameter. The right hand rest is provided with power traverse.

The driving dogs grip the rims of the wheels firmly, and by means of a cap, which is slipped on after the wheels are in place, buckling or distorting of the wheels is prevented. Two of these driving dogs are shown in the foreground of the illustration, one having the cap removed. The feed is taken directly from the face plate, and the feed lever is placed so that the operator can adjust the amount of feed without leaving the work. The face plates may be driven independently or together, as desired. The face plates have 20 speeds ranging from .227 to 2.68 r.p.m. for turning tires and from 4.53 to 54 r.p.m. for turning journals. The machine weighs 90,000 lbs., and is driven by a 30-h.p. motor. If desired, it may be equipped with a quartering attachment.

Employees' Saving Fund.—The employees' saving fund of the Pennsylvania Lines West of Pittsburg, amounted to $459,276.53 on December 31, 1905. The members received 4 per cent. on their deposits.



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INTERLOCKING MILLING CUTTERS.

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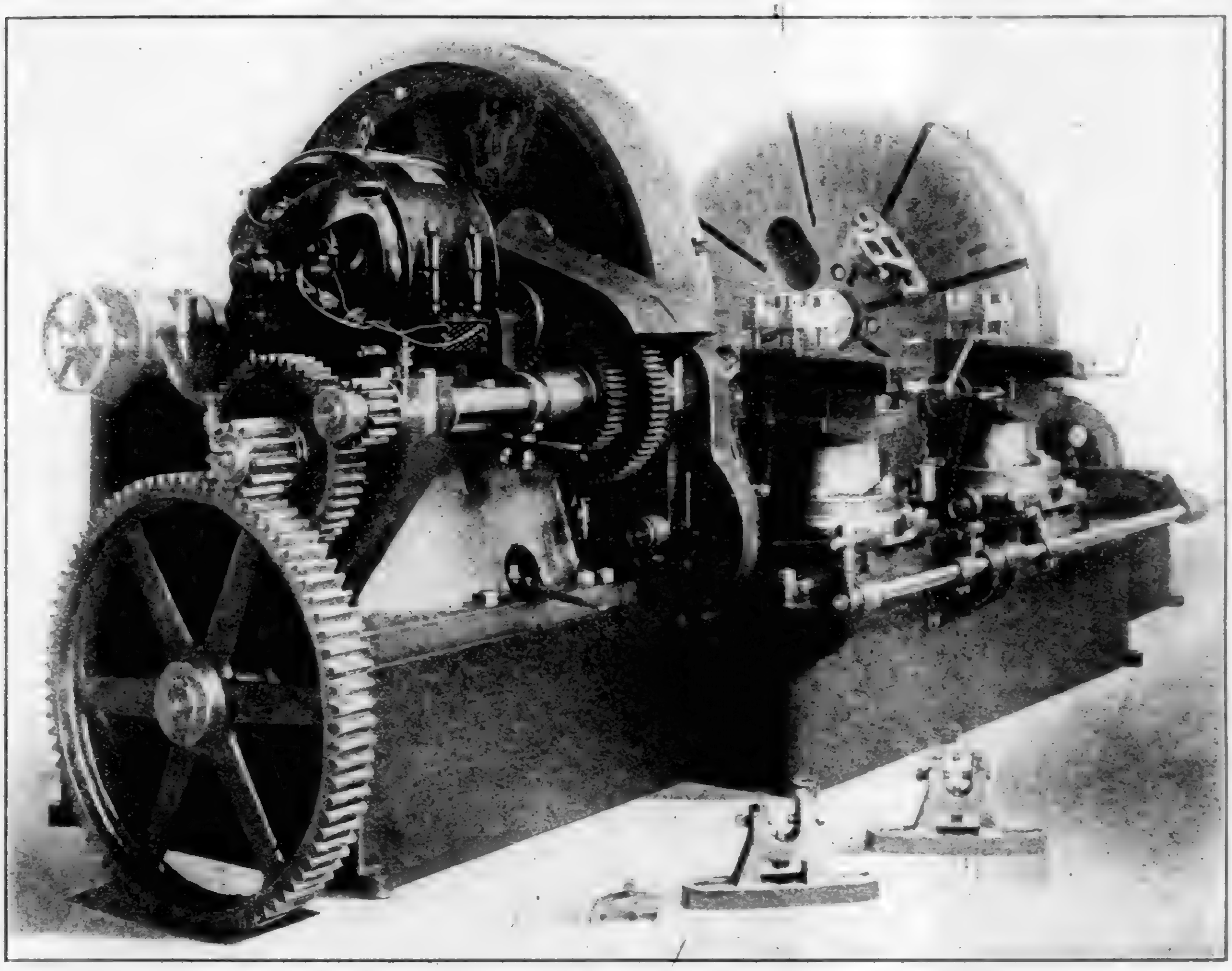

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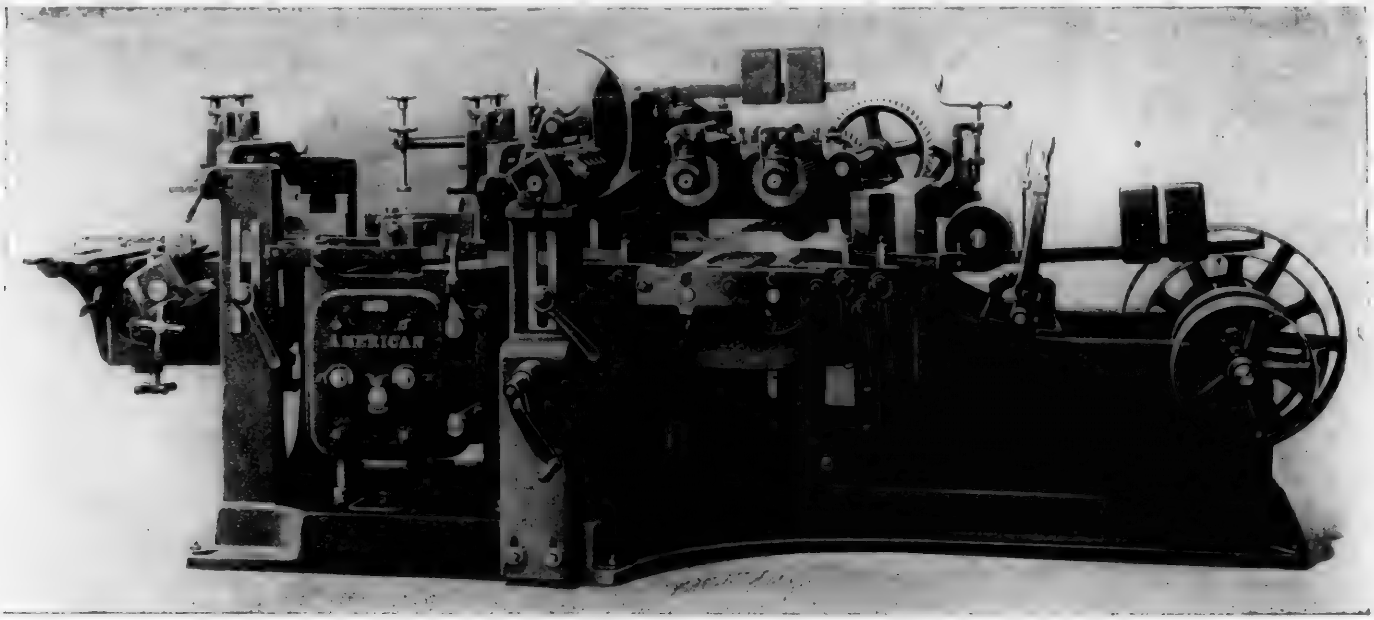
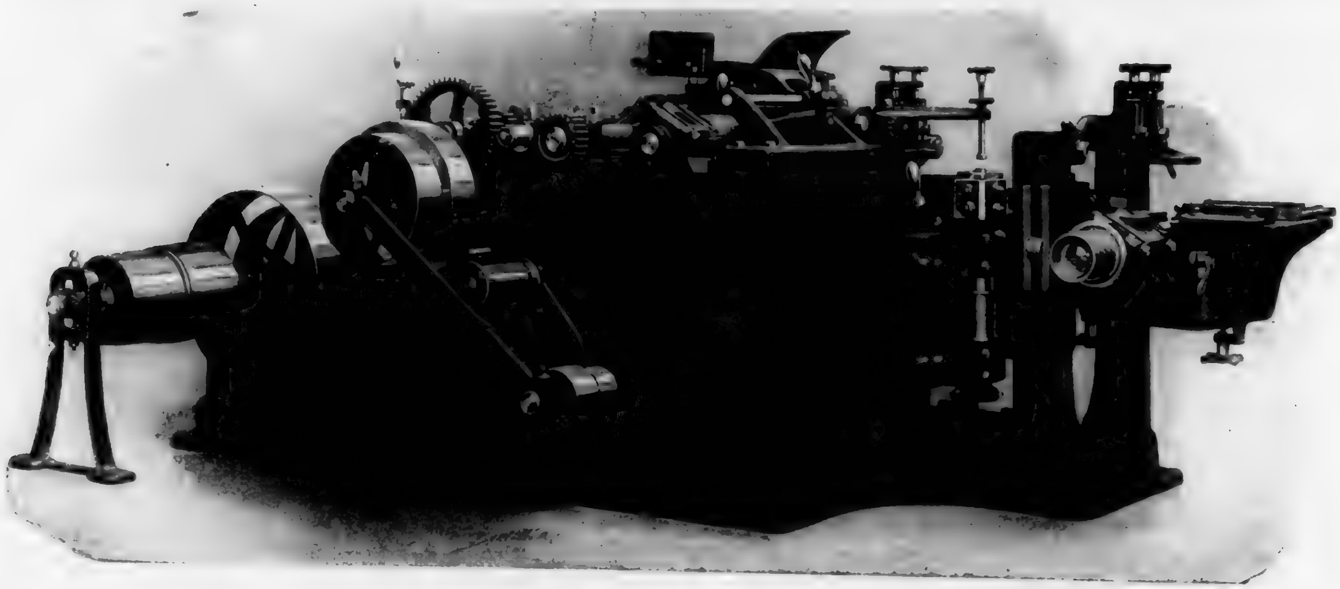
The sides of the tool rests next to the face plates are cut away at the top and reinforced on the under side, in order to allow the driving dogs to be brought as near the rim of the wheel as possible. The tool blocks have swiveled compound slides, with power feed in any direction, and may be set to turn wheels from 48 to 90 ins. in diameter. The right hand rest is provided with power traverse.

The driving dogs grip the rims of the wheels firmly, and by means of a cap, which is slipped on after the wheels are in place, buckling or distorting of the wheels is prevented. Two of these driving dogs are shown in the foreground of the illustration, one having the cap removed. The feed is taken directly from the face plate, and the feed lever is placed so that the operator can adjust the amount of feed without leaving the work. The face plates may be driven independently or together, as desired. The face plates have 20 speeds ranging from .227 to 2.68 r.p.m. for turning tires and from 4.53 to 54 r.p.m. for turning journals. The machine weighs 90,000 lbs., and is driven by a 30-h.p. motor. If desired, it may be equipped with a quartering attachment.

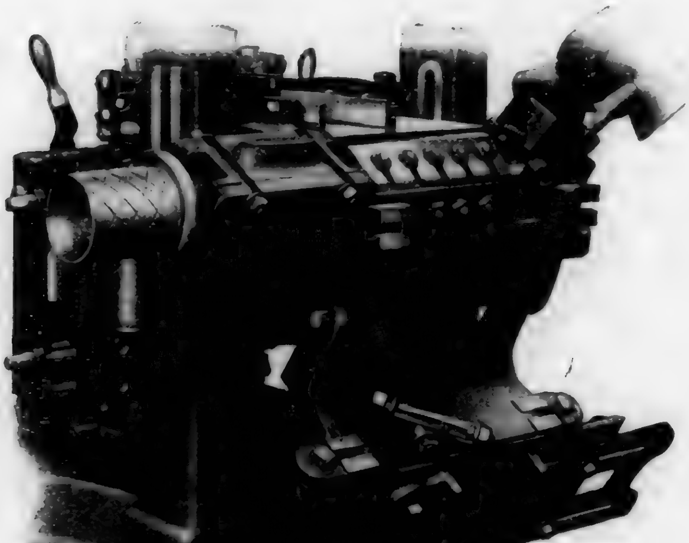
Employees' Saving Fund.—The employees' saving fund of the Pennsylvania Lines West of Pittsburg, amounted to $159,276.53 on December 31, 1905. The members received 4 per cent. on their deposits.



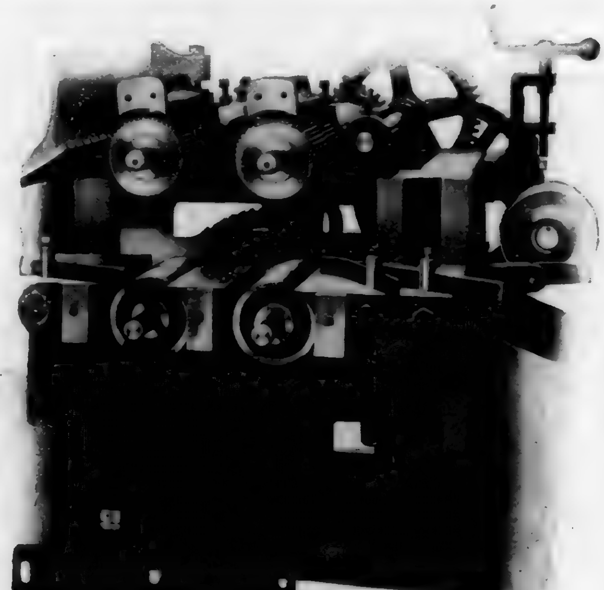
FRONT VIEW.



REAR VIEW.



END VIEW—BED DOWN, SHOWING BOXES, ETC.

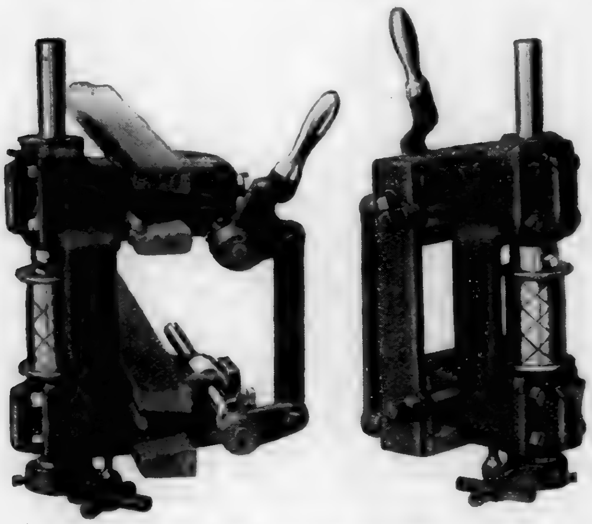


ROLLS AND DETACHED BOXES.

AMERICAN FOUR-COLUMN OUTSIDE MOULDER.

NEW FOUR COLUMN OUTSIDE MOULDER.

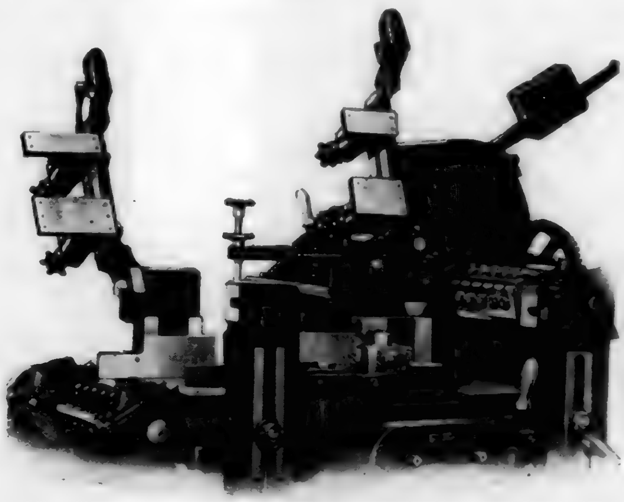
The American four-column outside moulder, shown in the illustrations, is made in two sizes and will work all four sides of a piece 12 or 14 ins. wide by 6 ins. thick; the table drops 8 ins. The machine is easily adjusted and has several mechanical devices, a few of which are illustrated, that greatly increase its capacity. In addition to the frame, the base supports three columns; one column supports the outer end of the top arbor, preventing vibration when taking deep cuts; the other two support the rear end of the bed carrying the bottom cutter head. The bed is securely gibbed to the frame and is raised and lowered by two large screws, which rest on ball bearings and are both operated by the same crank. There is a detachable bed plate directly under the top cutter head, which is reversible, with one side plain and the other side grooved, to allow the cutters to project lower than the bed. The extension of the bed beyond the bottom cutter head drops down, giving free access for adjusting the cutters.



INSIDE AND OUTSIDE HEADSTOCKS.

The feed rolls are 6 ins. in diameter and have an improved direct-gear drive for the top and bottom rolls, making a powerful and positive feeding device. The feed rolls are supported with outside bearings and the bottom rolls can be removed and replaced by removing three bolts, as shown in one of the illustrations, and without disturbing any part of the machine proper. The spindles are of large diameter, run in self-oiling boxes and are provided with what is known as a pneumatic pulley, overcoming the necessity for tight belts, with a consequent saving in power. The top and bottom spindles are equipped with patent side-clamping boxes, which may be easily and accurately adjusted. The belt driving the top head has an adjustable tightener, by means of which the slack may instantly be taken up and permitting no greater strain than is necessary when running on a lighter class of work.

The bars that carry the adjustable cutter shoes, over the under cutter and directly back of the top cutter head, are hinged and may be thrown back; they are supported at both ends and each shoe is vertically adjustable by a screw and hand wheel. The chip breaker and hood for the top head may be thrown up and back across the machine, giving free access to the top head. The side head may be set to any angle and moved vertically and laterally without changing the angle, and one movement of the lever locks the head stock at both the top and bottom.



UPLIFTED BARS. CHIP BREAKER SWUNG UP AND SLID ALONG, GIVING FREE ACCESS TO CUTTER HEAD KNIVES.

There is a lever adjustment for the independent bed-plate section before the bottom head, for unlocking and adjusting without the use of a wrench.

The cutter heads are provided with vertical and lateral adjustments and have a normal cutting circle of 6 ins. The top head cutters project 3 ins., giving a cutting swing of 6 ins. over the normal cutting circle, making 12 ins. maximum swing. The under cutter head is provided with an adjustable plate each side of the head, allowing the knives to project 3 ins. The inside head has an adjustable chip breaker and guide, allowing the knives to project 2½ ins. The outside head has a combined chip breaker and guide, allowing the knives to project 2½ ins. Four rates of feed are provided: 17, 25, 34 and 49 ft. per minute. The weight of the 14-in. machine is 7,200 lbs. These machines are made by the American Wood Working Machinery Company.

PERSONALS.

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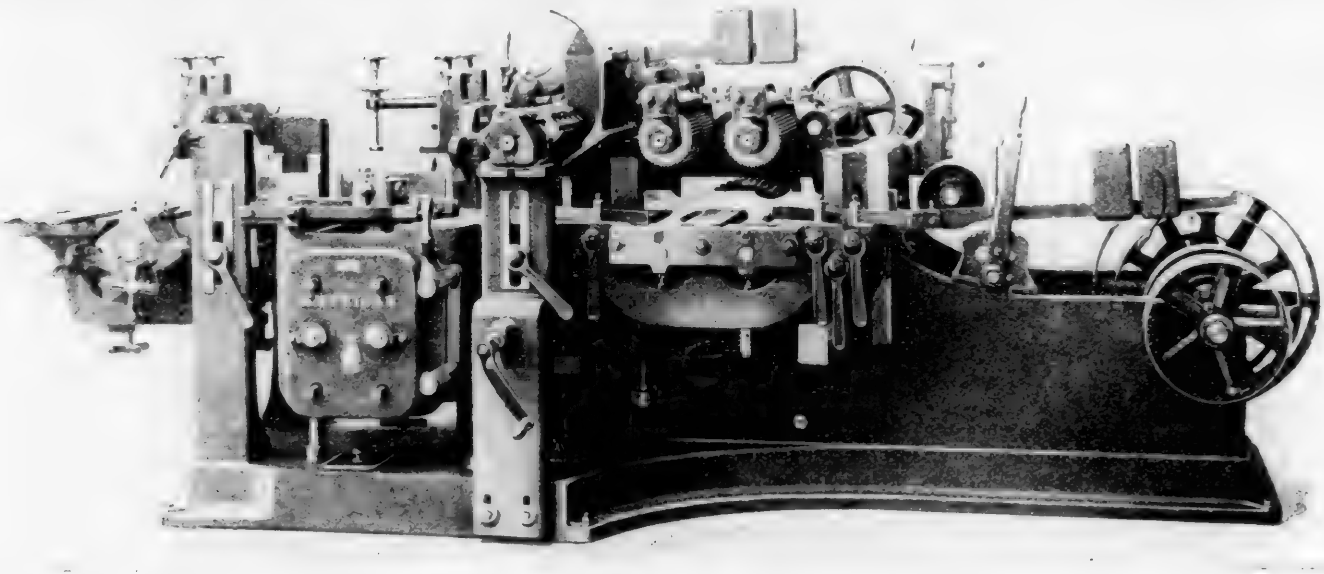
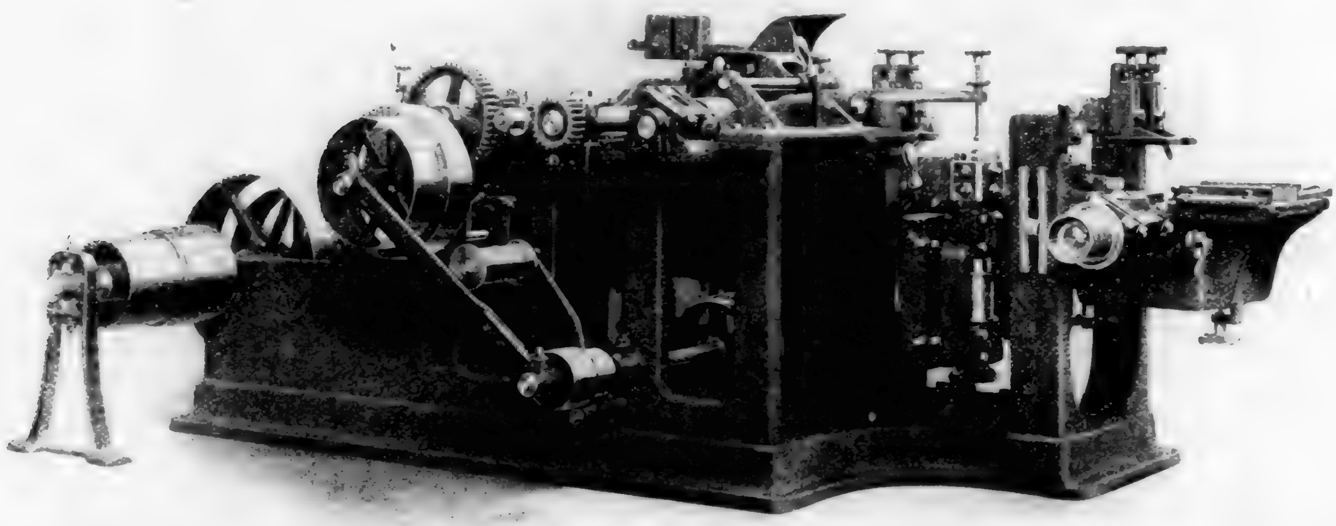


FRONT VIEW.



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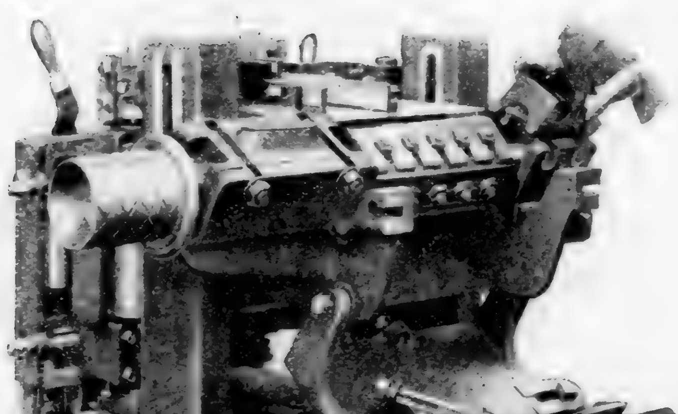
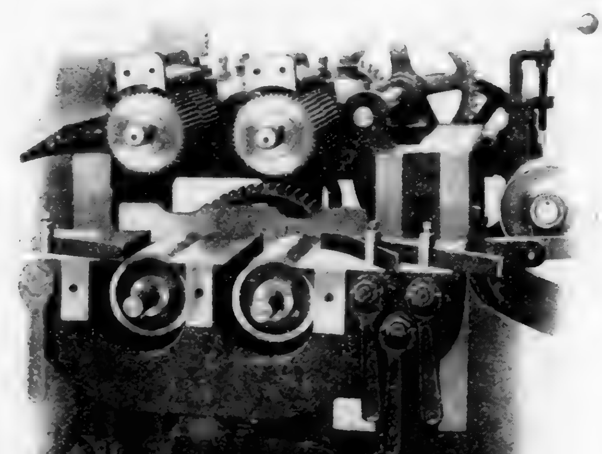


END VIEW—BED DOWN, SHOWING BOXES, ETC.



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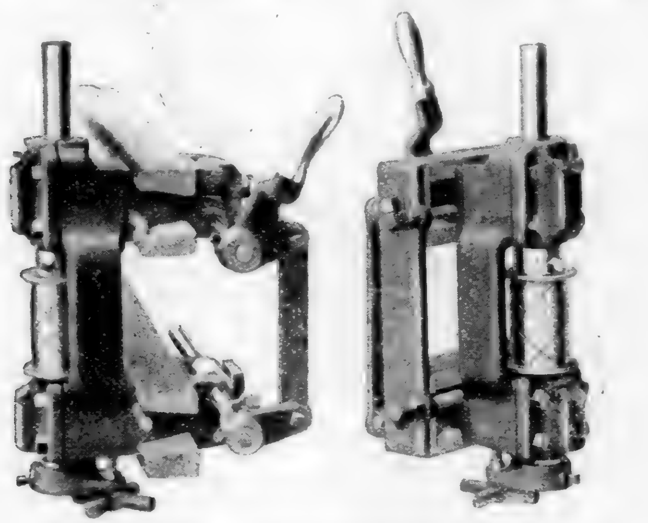

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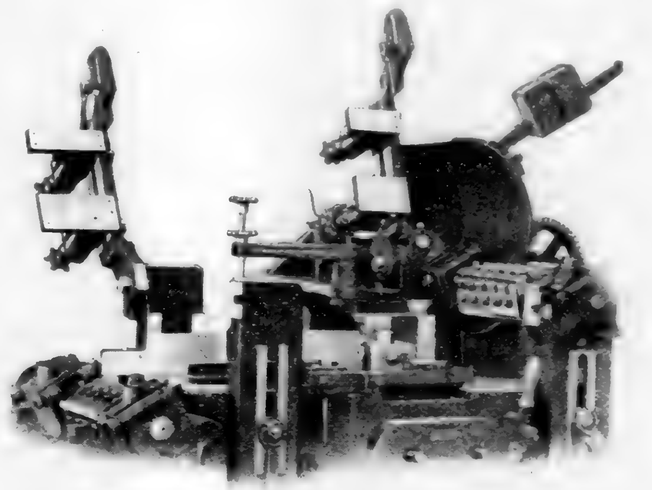

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Mr. R. L. Kleine, general car inspector at Altoona, Pa., has been appointed assistant chief car inspector, with headquarters at the same place.

Mr. W. S. Miller, master mechanic on the Pennsylvania Lines at Columbus, O., has resigned to become vice-president and general manager of an electrical company of Philadelphia.

Mr. W. J. Pollock has resigned as foreman of the Pennsylvania Railroad freight car repair shop at Altoona, Pa., to go into private business.

Mr. J. J. Clark has been appointed master mechanic of the Nashville Terminal Company, with office at Nashville, Tenn., to succeed Mr. G. B. Longstreth, resigned.

Mr. D. J. McNerney has been appointed master mechanic of the Tacoma Eastern Railway, with office at Bismarck, Wash., succeeding Mr. H. F. Weatherby.

Mr. M. J. Henegan has been appointed road foreman of engines of the Cleveland, Akron & Columbus Railway, at Columbus, Ohio, vice Mr. J. B. Ward, resigned.

Mr. C. D. Young has been appointed assistant master mechanic of the Pennsylvania Lines, Northwest system, at Fort Wayne, Ind., vice Mr. N. M. Loney, promoted.

Mr. N. M. Loney, assistant master mechanic of the Pennsylvania Lines, Northwest System, at Fort Wayne, Ind., has been appointed assistant engineer of motive power at Fort Wayne.

Mr. Oscar Antz, general foreman on the Lake Shore & Michigan Southern Ry., at Elkhart, Ind., has been appointed general locomotive inspector of the New York Central Lines.

Mr. H. S. Needham has been appointed assistant motive power inspector of the Pennsylvania Lines, southwest system at Columbus, O., to succeed Mr. Charles D. Young, promoted.

Mr. A. C. Davis, heretofore assistant engineer of motive power of the Northwest system, Pennsylvania R. R., at Fort Wayne, Ind., has been appointed master mechanic at Wellsville, O.

Mr. H. F. Ball, superintendent of motive power of the Lake Shore & Michigan Southern Railway, with headquarters at Cleveland, O., has had his jurisdiction extended over the Chicago, Indiana & Southern Railroad.

Mr. C. O. Keagy, general foreman of passenger car inspectors at the West Philadelphia shops, Pennsylvania R. R., has been appointed general car inspector at Altoona, to succeed Mr. Kleine.

Mr. W. A. Moody, heretofore chief draftsman of the Illinois Central R. R., has been appointed acting mechanical engineer with office at Chicago, succeeding Mr. J. H. Wynne, mechanical engineer, resigned.

Mr. F. P. Pfahler, heretofore draftsman of the Baltimore & Ohio Railroad, at Baltimore, Md., has been appointed mechanical engineer of the Wheeling & Lake Erie Railroad, with office at Norwalk, Ohio.

Mr. H. S. Lloyd has been appointed master mechanic of the Chattanooga Southern R. R., with headquarters at Alton Park, Tenn., and Mr. J. B. Crabb has been appointed foreman at that place.

Mr. George B. Fravel has been appointed master mechanic of the Logansport division of the Pennsylvania Lines, southwest system, with office at Logansport, Ind., to succeed Mr. G. C. Bishop, resigned.

Mr. J. T. Flavin has been appointed master mechanic of the Chicago, Indiana & Southern Railroad at Hammond, Ind., and Kankakee, Ill. Heretofore Mr. Flavin has been assistant master mechanic of the Indiana, Illinois & Iowa R. R.

Mr. C. H. Mead, general car foreman of the Iowa Central at Marshalltown, Ia., has been appointed master car builder of the Isthmian Canal Commission, under Mr. George D. Brooke, superintendent of motive power at Ancon, Panama.

Mr. G. C. Bishop, master mechanic of the Pennsylvania Lines, Southwest system, at Logansport, Ind., has been appointed superintendent of motive power of the Long Island R. R., with office at Richmond Hill, Morris Park, N. Y., to succeed Mr. Phillip Wallis, resigned.

Mr. W. L. Harrison, heretofore master mechanic of the Chicago, Rock Island & Pacific Railway, at Horton, Kans., has been appointed acting superintendent of motive power, with office at Chicago, during the illness of Mr. J. B. Kirkpatrick. Mr. S. W. Mullinix has been appointed master mechanic at Horton, to succeed Mr. Harrison.

Mr. A. E. Mitchell has resigned as superintendent of motive power of the Lehigh Valley R. R., to be effective June 1. He will be succeeded by Mr. F. N. Hibbits, mechanical superintendent of the New York, New Haven, & Hartford R. R., who in turn, will be succeeded by Mr. Frank T. Hyndman, general master mechanic of the N. Y., N. H. & H. R. R.

Mr. J. J. Walsh, general foreman of the Pennsylvania Lines, Northwest system, at Toledo, O., has been transferred to Chicago as master mechanic of the Chicago Terminal division, succeeding Mr. George B. Fravel, transferred. Mr. O. P. Reese, heretofore motive power inspector, has been appointed general foreman at New Castle, Pa., in place of Mr. T. F. Dreyfus, who has been appointed to succeed Mr. Walsh as general foreman at Toledo.

BOOKS.

Shaft Governors. By W. Trinks and C. Housum. 97 pages. Published by D. Van Nostrand Company, New York. Price, 50 cents.

This volume, which is expected to be the first of a series on this important subject, is given up largely to the statistics of shaft governing and contains a large amount of matter illustrated with plates, in connection with the design of satisfactory shaft governors. The subject is treated very thoroughly.

Manual for Engineers. Compiled by Chas. E. Ferris. Sixth Edition. Published by the University of Tennessee, Knoxville. Price, 50 cents.

This small pocket book contains a large amount of valuable matter for both engineers and business men in the shape of detailed and general information. The first few pages are devoted to a brief account of the courses offered at the University of Tennessee. The book is of vest pocket size, printed on thin paper with a flexible cover.

Tests of Metals. Government Printing Office, Washington, D. C.

This book is a report of the tests made with the United States testing machine at the Watertown Arsenal during the year ending June 30, 1905. It contains a full account of tests, to the number of 32, on a large variety of subjects, including steel castings and forgings, steel wire, helical springs, roller bearings, railroad material, concrete, brick, marble, blue print paper and many others. The book is nicely illustrated with half-tone engravings on special surface paper and contains much valuable matter.

The Indicator Hand Book. By C. N. Pickworth. Third Edition. 126 pages. Published by D. Van Nostrand Company. Price, 75 cents.

This book, which is very profusely illustrated, is prepared for the purpose of furnishing engineers with a practical hand book which fully describes the modern indicator and its application. It discusses the errors of the instrument, particularly those due to its faulty attachment and actuation, and considers methods for correcting them. Many different types and designs of indicators are shown, as well as many forms of connections. Steam pipe connections, valves, etc., are included.

Reinforced Concrete. By F. D. Warren. 271 pages. Published by D. Van Nostrand Company. Price, $2.50.

The author states that he has endeavored to produce a reference hand book that would be useful to architects, engineers and contractors. The book is divided into four parts, the first of which contains a general review of the subject from a practical standpoint, bringing out some of the difficulties met with in practice and suggesting remedies. Part two is a series of tests justifying the use of various constants and co-efficients. Part three is a series of tables from which the designer may obtain necessary information to meet the common cases in practice. Part four treats of the design of trussed roofs from a practical standpoint. The book contains a number of illustrations in addition to many curves and tables.

Details of Bridge Construction. Part II. Plate Girders. By Frank W. Skinner. Published by the McGraw Publishing Company, 114 Liberty Street, New York, N. Y. 1906. Illustrated. 412 pages. Price, $4.00.

The volume is divided into six parts, as follows: General features of design, construction and service; examples of railroad plate girder spans; details of bearings and splices; multiple railroad spans on steel towers; highway and special spans; discussion of plate girders by eminent designers. It is intended to make it a complete epitome of American practice in plate girders, to describe and illustrate as many important examples as possible, to accompany them with a comprehensive review of ordinary conditions, requirements, methods and explanations of the computation, design and execution of the work and to arrange the data so as to present a complete record for reference and consultation, useful for design and estimate, and especially for convenient illustration and comparison of plate girder essentials, for guidance, suggestion, or modification in new work.

Electrical Engineering in Theory and Practice. By G. D. Aspinall Parr, Head of the Electrical Engineering Department, The University, Leeds. Published by The Macmillan Company, 66 Fifth Avenue, New York City. 1906. 450 pages. 282 illustrations. Price, $3.25.

Except in a few cases where they embody important principles, all historical matter and obsolete appliances have been excluded, the endeavor being to produce a work fully up to date. The fundamental principles of magnetism and electricity are first considered, and this is followed by chapters on electrical resistance, electro-magnetism, electro-static and electro-magnetic induction, electrical and magnetic instruments, incandescent lamps, arc lamps, and the production of electro-motive force (thermo-generators, primary and secondary cells). It is expected that the theory of the generation, transformation and distribution of continuous and alternating currents, together with electrical machinery and other appliances most commonly met with in electrical engineering will form the subject matter of a second volume. A series of carefully chosen questions are given at the end of each chapter.

CATALOGS.

IN WRITING FOR THESE, PLEASE MENTION THIS PAPER.

TRANSFORMERS.—Bulletin No. 65 from the Crocker-Wheeler Company, Ampere, N. J., contains a reprint of an illustrated article by A. H. Pikler in the *Electrical World*, describing their core type transformers, manufactured in all sizes up to 4,000 kva, for any commercial frequency and for all votages up to 200,000.

WILLIAMS FRICTION CLUTCH.—The Williams Electric Machine Company, Akron, Ohio, is issuing a leaflet descriptive of a special design of friction clutch manufactured by it, which contains a number of interesting features. These clutches are very compact and are capable of transmitting a large amount of power.

TRUCKS ET VOITURES DE LA J. G. BRILL CO.—The J. G. Brill Company, of Philadelphia, is issuing a special catalog in French under the above title, which is intended for distribution in connection with its exhibit at the Milan Exposition. This is arranged in a most artistic manner and shows many illustrations and drawings of the special trucks and electric cars manufactured by them.

VENTILATORS.—The Globe Ventilator Company, Troy, N. Y., is issuing a pamphlet devoted principally to the application and value of the Globe ventilator for use on passenger coaches. The important subject of proper passenger car ventilation is briefly considered and the success obtained by the use of the Globe design is shown. This type of ventilator is also in use on many shops and roundhouses.

BUDA HAND CARS.—The Buda Foundry & Manufacturing Company, Railway Exchange, Chicago, is issuing a catalog which illustrates and describes many different designs of hand cars, push cars and railway velocipedes, all of which are equipped with the Buda pressed steel wheel, which is also shown in section. The method of manufacture and advantage of this type of wheel are clearly set forth.

LOCOMOTIVE CRANES.—The Wellman-Seaver-Morgan Company, Cleveland, Ohio, is issuing a catalog containing a number of illustrations showing locomotive cranes of different sizes operating under different conditions, both in connection with buckets for hoisting coal or ore, as well as a regular crane for the distribution of heavy parts. These cranes are used at some points for coaling locomotives, removing cinders from the cinder pit and similar work.

AIR COMPRESSORS.—The Ingersoll Rand Company, 11 Broadway, New York, is issuing a very complete catalog giving illustrations, descriptive matter and details of sizes and capacities of a large number of different designs of air compressors manufactured by it. These are shown for driving with steam, electricity or water power, in both vertical and horizontal connections. Reheaters, tanks and details of the air compressors are also illustrated and described.

WATER SOFTENING.—William B. Scaife & Sons Company, Pittsburg, Pa., is issuing a small folder, the outside having the appearance of a ledger, which includes a photographic reproduction of two pages of an actual ledger kept by a manufacturing company operating a 2,000 h.p. boiler plant, one page of which shows the cost of maintenance of boilers before and the other after the installation of water softening and purifying plants. The figures are most interesting and the leaflet can be obtained upon request.

MACHINE TOOLS.—*Progress Reporter*, No. 12, published by the Niles-Bement-Pond Company, describes several machine tools which are of special interest to those interested in railroad shop operation. Among them is a four-head milling machine, 79-in. standard driving wheel chucking lathe, 66-in. vertical milling machine, 300-ton hydraulic wheel press, 12in. crank slotter, two-head frame slotter, four-spindle multiple drill, locomotive rod boring machine, 200-ton sectional hydraulic flanging machine and a motor-driven bending rolls.

CHICAGO CAR HEATING COMPANY.—A very attractive catalog has been issued by the Chicago Car Heating Company, Railway Exchange Building, Chicago, which thoroughly describes the new vapor system of car heating recently perfected, as well as the straight steam pressure system and hot water systems furnished by it. The catalog contains several large colored plates, sectional elevations of apparatus and perspective views of installments for the different systems, and reading matter which covers every point of operation. A large number of appliances and parts used in connection with car heating apparatus are also shown and described.

TEST OF ROLLER BEARINGS VS. GRAPHITE.—The May issue of "Graphite" contains an account of some tests recently made by Professor Benjamin, of the Case School of Applied Science, as a supplement to the tests recently made by Professor Goss, of Purdue University, which showed a large reduction of friction by the use of graphite as a lubricant. These experiments were a comparison of the friction developed by a plain bearing with graphite lubricant and ordinary roller bearings, and showed that the latter gave nearly four times the co-efficient of friction when the pressure was 50 lbs. per sq. in. The test also showed that the bearing lubricated with graphite was able to carry a load nearly 100 per cent. greater than the roller bearing.

RECORD OF RECENT CONSTRUCTION No. 55.—The latest Record of Recent Construction issued by the Baldwin Locomotive Works is entitled "Walschaert Valve Gear," and contains a large amount of historical, descriptive and instructive matter in connection with this type of valve gear. The descriptive matter contained in this pamphlet was partially reprinted in the AMERICAN ENGINEER AND RAILROAD JOURNAL, February, page 55. General views and dimensions of a number of locomotives which have been built by this company equipped with this type of gear are also shown. In view of the increasing popularity of the Walschaert valve gear in this country, the matter contained in this book will be found to be of interest and value to all motive power men.

Motors and Generators.—Bulletin No. 64, from the Crocker-Wheeler Company, Ampere, N. J., describes their type I motor and generator and illustrates a number of motor applications to machine tools. Some modifications have recently been made in the frame of this motor so that it has all the advantages of the open type, but may be fully enclosed if conditions or operation so require.

General Electric Company.—This company during the past month has issued several very interesting catalogs dealing with electrical apparatus. One of these, entitled "Lightning Arresters," considers the important question of protection from lightning shocks in general and describes an improved form of multiplex arresters recently perfected by this company. Other and older types for all currents and voltages are also shown in the catalog and its supplement. This includes many diagrams of wiring connections under different circumstances. A supply catalog giving illustrations with detail parts and a complete price list of the Sprague General Electric type M control apparatus is also being sent out. A similar supply catalog of marine supplies for electrical work of all kinds can also be obtained by those interested.

Pacific Type Passenger Locomotives.—A pamphlet just issued by the American Locomotive Company describes Pacific type passenger locomotives built for various railroads. The pamphlet opens with a description of the Pacific type and an outline of its special advantages for very heavy and fast passenger service. These are very briefly stated and are followed by a description of two forms of trailing trucks which have been used with great success on this type of locomotive. The description is followed by two pages of tables containing, in condensed form, the leading dimensions of all the locomotives illustrated in the pamphlet, the tables being arranged in the order of the total weight of the locomotives. By use of side elevation and sectional drawings a typical Pacific type locomotive is illustrated and engravings of outside and inside bearing trailing trucks are included. The remainder of the pamphlet is devoted to photographic reproductions of locomotives, the opposite pages containing tabular information concerning each design. The locomotives are placed in the order of their weights.

This is the first of a series of catalog pamphlets to be issued by the American Locomotive Company, which will eventually include all the standard types of locomotives, and will constitute a record of the production of the company. Copies of the pamphlet can be obtained upon request.

NOTES.

Otto Gas Engine Works.—This company announces change of address from 360 Dearborn St. to Room 1203, 357 Dearborn St., Chicago, Ill.

Railway Materials Company.—This company announces that after May 1st its New York office will be located at the Washington Life Building, 141 Broadway.

Star Brass Manufacturing Company.—The New York office of this company has been removed from 38 Cortlandt St. to 70 Cortlandt St., where larger quarters are available.

Fairbanks-Morse and Company.—The San Francisco office of this company is now temporarily located at 969 Broadway, Oakland, Cal., where they will remain until able to return to their previous location in San Francisco.

Chicago Pneumatic Tool Company.—The quarterly report recently issued by this company for the first quarter, 1906, shows the profits for that time to have been over $233,000, leaving a balance of nearly $95,000 to be carried to surplus. The surplus of the company is now nearly $606,000. It is stated that the business for the month of April was about 10 per cent. in excess of the same period last year.

Test of Falls Hollow Staybolt Iron.—The following is the average result of a test of 16 samples of Falls Hollow staybolt iron, taken from regular stock, by the Baldwin Locomotive Works. The iron was 1 in. outside diameter and 3/16 in- inside: Tensile strength, 50,833 lbs. per sq. in.; elongation, 32.33 per cent.; reduction of area, 49.1 per cent.; threading test, O. K.; double bending test, O. K.; vibratory test, the threaded specimens stood an average of 7,713 revolutions when subjected to a deflection of 3/32 in. and a tensile load of 4,000 lbs.; etching test shows the iron to be slab piled.

Falls Hollow Staybolt Company.—Messrs. Berger-Carter & Company, the Pacific Coast agents of the Falls Hollow Staybolt Company, who were formerly located at 34 Beale St., San Francisco, Cal., announce that they are now temporarily located at Third and Washington Sts., Oakland, Cal., where they have installed a complete new stock.

Heating and Ventilating Apparatus for the United Engineering Building.—The heating and ventilating apparatus of special construction which will be installed in the United Engineering Building, the cornerstone of which was recently laid on West 39th Street, New York City., is to be furnished by the B. F. Sturtevant Company, of Boston, Mass.

Niles-Bement-Pond Company Exhibit at Atlantic City.—During the Master Car Builders' and Master Mechanics' conventions to be held at Atlantic City, June 13-20, the Niles-Bement-Pond Company will have on exhibition and *in full operation* one of their extra heavy 90-in. driving wheel chucking lathes. This will afford an exceptional opportunity to observe this machine at work. Owing to its great weight it cannot be shown on the steel pier. They have therefore built a special booth, two minutes' walk from the Pennsylvania Station on New York Avenue, near Atlantic Avenue, where you are cordially invited to witness a demonstration of this machine.

Crocker-Wheeler Company.—Mr. H. C. Baker, formerly in charge of the Atlanta office territory of the Crocker-Wheeler Company, has started for San Francisco, where he will take charge of the Pacific Coast territory of this company. The offices at Fremont and Howard Sts., San Francisco, were completely destroyed by the recent fire; temporary offices have been established at 2611 Broadway. Mr. Baker will enter an active field of electrical development in which the company is already conspicuously established by its installation of 4,000 KVA alternating current generators in the plant of the California Gas & Electric Corporation. These machines, the largest gas-engine-driven alternators in the world, escaped damage in the recent disaster.

New Buildings and Equipment at Purdue.—In order to provide for the constantly increasing number of students, Purdue University is adding a number of new buildings and considerable new equipment. A new building for the school of civil engineering will be ready at the beginning of the next school year, as will also an addition to the electrical laboratory, which will enclose the test car Louisiana deposited with the University by the American Street and Interurban Railway Association. It will be equipped with an overhead travelling crane. The mechanical engineering laboratory will also receive considerable new equipment, which, in addition to much small apparatus, will include an Ingersoll Rand compound duplex air compressor, a 50-h.p. gas producer with gas engine, several smaller gas engines, an Allis Chalmers direct-connected engine and centrifugal pump, a DeLaval steam turbine and centrifugal pump, a 100-h.p. compound marine engine and all auxiliary apparatus.

Resorts for the Vacationist.—The passenger department of the Boston & Maine Railroad has, according to its annual custom, just issued an illustrated pamphlet (80 pages) which describes the resorts for the vacationist, reached via the Boston & Maine Railroad and its stage and steamer connections, and contains a list of the hotels and boarding-houses, with their rates and accommodations, in this territory. These resorts are divided, for convenience, into three classes, the mountain, the seashore and the river, lake and inland resorts. Information is given as to the stage and steamboat connections and in addition there is a large map of the territory considered, and also three small maps, St. Andrews, N. B., and vicinity, White Mountain Region and Mount Desert Island and vicinity. Copies of this publication, and also one on excursion rates and tours, may be had free upon application to the passenger department at Boston, Mass. The following booklets which give in greater detail a description of the different vacation sections, as well as those resorted to by the hunter and the fisherman, will be sent on receipt of two cents in stamps for each book: Fish and Game Country, All Along Shore, Among the Mountains, Lakes and Streams, The Valleys of the Connecticut and Northern Vermont, Hoosac Country and Deerfield Valley, Central Massachusetts, Merrimack Valley, Lake Sunapee, Lake Memphremagog and About There, Vacation Days in Southern New Hampshire.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL

JULY, 1906.

ADDRESS OF PRESIDENT BALL.

MASTER MECHANICS' ASSOCIATION.

From the inception of the association, thirty-eight years ago, each successive convention has marked a period of advancement in our work. At this meeting we will have presented to us, matters of even greater importance than have been considered heretofore, and this convention, above all others, will mean more to us as representatives of that important factor in railroad transportation,—the motive power department,—than any of the conventions which have become matters of history.

The past year has been noteworthy as a record breaker in the continuation of the prosperous conditions which have prevailed during the past decade. Exceptionally favorable weather conditions, combined with large additions to equipment, which our superiors had taken the precaution to provide, enabled the railroads to meet the emergency in a creditable manner. Locomotive and car plants have been taxed to their utmost capacity to meet the requirements of the railroads, whose orders in many cases were the largest placed in railroad history.

Statistics compiled for the year 1905 show a large increase in output of new locomotives, over the year 1904, as the following data will indicate:

	1905.	1904.	Inc.
Total number of locomotives built for domestic use and for export, by locomotive builders	5,491	3,441	60%
Total number of locomotives built for domestic use by the builders, and in railroad shops	5,176	3,198	61%
Compound locomotives built for domestic use	177	132	34%
Balanced compound locomotives built for domestic use	76	41	85%
Number of electric locomotives built	140	95	47%

The tendency in locomotive building during the year has been along conservative lines—no radical changes in general design being noticeable. The 4-cylinder balanced compound has not progressed in general favor as rapidly as was anticipated; its extended use being confined largely to those roads which participated in its early introduction. In view of the economy obtained in tests at the St. Louis testing plant, it is certainly deserving of more attention.

The Mallet type of locomotive, which is specially designed to meet conditions requiring a very powerful locomotive, is another type which is not being introduced as fast as its merits will warrant.

The most noteworthy change in detail design of the locomotive, one that marks a departure from long established American practice, is the acceptance of the Walschaert valve gear. This form of valve gear lends itself admirably to the heavy locomotive, having advantages in the way of accessibility for inspection and repairs, lightness, and freedom from rapid wear.

The rapidity with which this gear has grown in favor with enginemen, as well as those who have to do with the maintenance of the engine, promises well for its future. Up to the 1st of January, 1906, there were 283 locomotives equipped with the Walschaert valve gear in this country; and as an indication of the tendency toward the general adoption of this gear, one road to-day has 225 engines equipped with it.

In boiler design, much has been done incidental to the introduction of the superheater, and more will undoubtedly follow as designers take up the problem of superheating of steam for locomotive engines. Apart from this, the most radical departures in boiler design are found in the use of a combustion chamber, in long boilers using bituminous coal, with attendant remarkable results in overcoming rapid deterioration of flue ends and leaking. It is also worthy of note, that the flexible staybolt is steadily gaining ground.

To meet the changed conditions in railway operation, as a result of the growth of the locomotive in recent years, no equipment detail furnishes a better example of progress than the advancement made in railway braking appliances. The problem of braking trains, having from four to five times their former weight, with double the number of cars, has been solved successfully, and with apparatus greatly simplified. The new engine and tender equipments represent a consolidation of all previous locomotive equipments, as far as effects are concerned, with a centralization of the functions of the different apparatus into one unit, thereby eliminating a great many parts.

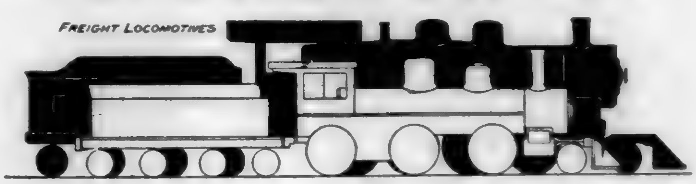
Aside from what has been accomplished in the direction named, changes for economy of operation have also received attention. The introduction of the cross-compound air pump is opportune. The demands for air have increased to such an extent as to represent quite a large percentage of the boiler capacity for its production. It has been found that under normal working of a large freight locomotive, hauling a train of 65 cars, 50 of which were air-braked, at 20 miles per hour, the simple air pump requires approximately 6 per cent. of the steam generated. If a portion of this can be saved by compounding, such saving should not be overlooked. Tests which have been made, show an economy for the compound pump, of 60 per cent. over the single pump.

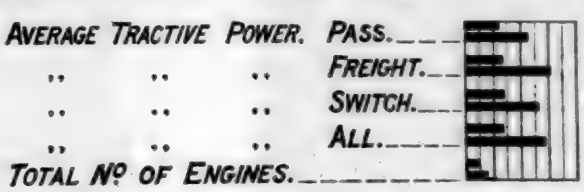
A list of improvements in details would not be complete without a mention of the advancement made in the art of manufacturing rolled steel wheels. Their increasing use promises well for this type of wheel.

The motive power problem, "Reduced cost per ton mile of transportation," is presented to us to-day for solution, even more forcibly than it has been presented to those who preceded us, and is deserving of more careful consideration and study than what has been accorded it heretofore. This is not merely a mechanical problem. How has the problem been met from a motive power standpoint? By providing a locomotive, the size of which has only been limited by the governing clearance dimensions. But there is something more that we can do.

It may not be out of place to refer at this time to the advancement that has been made in power capacity during the past ten years, and to reflect with pardonable pride on our having participated in the splendid movement in the upbuilding of the locomotive, which the following figures represent. The data was obtained from a road with which you are all familiar and is fairly representative of the progress which has been attained on all roads in the country. To better illustrate the following figures, diagrams have been prepared.

AVERAGE TRACTIVE POWER 1896=13900. 1906=31500





In the years 1896 and 1906, the average tractive power for each class of engine, was as follows:

	1896.	1906.
For freight engines	13,900	31,500
For passenger engines	12,200	22,900
For switching engines	14,700	26,800
For all engines	13,700	28,700
Total number of engines, all classes	551	764

During the period of evolution represented by the foregoing figures, new difficulties arose; new problems required solution. In the desire for adequate boiler capacity within the limits of dimensions and weights imposed, errors were made in boiler design, in restricting the depth of the firebox, in the spacing of the flues and in the use of abnormal grate areas. With the greater use of cast steel, advantage was taken to reduce weights of details, to the extent of contributing the weight thus saved to further increase in the boiler dimensions. In some cases, such as wheel centers and frames, the lightness of the parts did not always result in failures, but their weakness contributed to the rapid wear, or failure of other dependent parts, and in other cases, failure of the parts themselves.

Experience has shown where errors of design have been made and a new basis for future calculations has been evolved, which has placed present design and construction on even a more satisfactory plane than that obtained with the lighter power. When the large locomotive went into commission the practices in vogue for the care and maintenance of the locomotive fell short of bringing results. In many cases, they brought disaster. Much of this was attributed to poor designs, when in reality the trouble lay in other directions. It was found a difficult matter to overcome flue leakage. A study of this subject by very able specialists in the motive power department has resulted in giving us definite rules regarding the care of the boilers, both on the part of the enginemen and roundhousemen, which are being extensively followed, with results as good, or better than were formerly obtained. The machinery of the locomotive, being heavier, also required special treatment at terminals, involving the adoption of the "stitch-in-time" policy, to keep the engine up to its maximum efficiency, and to avoid rapid deterioration, which was found to result from any neglect.

To provide the care necessary for the large locomotive, involved the expenditure of large sums for adequate terminals. Facilities for quick and frequent washing of boilers became imperative. Better drop pits, and more of them, were necessary. Engine houses with heating plants that would heat, and smokejacks that would ventilate, were required. The lighting of the house at night to provide for a continuous operation of the plant, on an efficient basis, was a recognized improvement. All this has been accomplished, and to-day we can be congratulated on having reached a plane of excellence, both in the design of the locomotive and in maintenance facilities, whereby the large locomotive is being handled just as expeditiously as the smaller one was, a few years ago.

Reports presented to this association on the subject of roundhouse terminals, at two former conventions, have had a marked influence in directing railroads to the appreciation of their shortcomings, in the way of adequate terminals and facilities and have played no small part in bringing about improved conditions.

How shall we meet the motive power problem in the future?

The rapid growth in power which marked the development of the locomotive in the past few years, and by which great economies of operation are being obtained, has apparently been arrested by the limitation of clearances, capacity of the firemen, and the reaching of the practicable train length limit. It would therefore appear questionable to look for further economies, as a general proposition, by continuing to enlarge the locomotive, under present conditions. The solution of the problem lies in other directions.

We shall be required to develop the mechanical stoker, compounding and superheating will be prosecuted with greater vigor than ever. The use of a feed-water heater may be resorted to, and among the smaller items, undoubtedly the compound air pump will be used, and perhaps the variable exhaust nozzle. We now have engines that will run successfully from terminal to terminal, and have reached a plane in the economical maintenance of our locomotives, whereby the use of the foregoing fuel-saving devices will make more apparent than heretofore the economies resulting therefrom. While considering the use of fuel saving devices, we must not lose sight of the economies that may be obtained through individual effort, with the facilities at hand.

This naturally leads to the subject of statistics. In following up fuel consumption on the average railroad, particularly where the pooling system is in vogue, the need for an up-to-date method of determining responsibility for the extravagant use of fuel is very apparent. Given proper weighing facilities, the problem presented is a systematic method for quickly determining at the end of each trip whether or not the coal used was in excess of the work performed, and, if so, the immediate placing of the responsibility, either with the crew or engine, as the case may warrant.

Another phase of the motive power problem, is the subject of organization. This subject has been referred to by former presidents, and while it is an old theme it presents increasingly difficult problems, if we would successfully cope with the progress of transportation. To obtain the best results in any organization, no one factor should be overtaxed. The progress of our railroads has been so great and the increase in business, while gradual, has been so persistent, that one is liable to awaken too late to the realization of having an organization inadequate to the demands placed upon it.

Consolidation of properties, and growth, have depreciated positions of the motive power department, compelling men to assume responsibilities beyond their positions. Those who have studied industrial and military organizations, find that one officer will supervise not to exceed from 26 to 30 men, while in railroad organizations, this will extend to 150 men.

In analyzing the result of consolidation, we find a master mechanic in charge of two or more divisions, where formerly only one was under his jurisdiction. After thus greatly increasing his duties, added responsibility was placed upon him by increasing the capacity of the locomotive from 50 per cent. to 100 per cent. and rapidly increasing their numbers. The same is true of roads which have not gone through the evolution of consolidation, brought about by natural growth.

We find that work is now being performed at important division enginehouses, of a character that was formerly taken care of at division shops. The work is supervised by the enginehouse foreman, acting in the capacity of the former division master mechanic, having oftentimes no special advantages at his command in the way of facilities for turning out work, with the disadvantage of an official title, the possession of which gives to the incumbent no consideration for either adequate compensation for services rendered, or proper respect for those under his jurisdiction, or consideration from those in other departments with whom he comes in contact. The modern enginehouse requires a bigger general at its head than the former small shop.

What has been said of the engine house foreman is also applicable to those subordinate in authority to him, and to those occupying similar positions of equal or greater responsibility in the shops, particularly as to compensation. Increase in wage rates granted to laboring men from time to time, very rarely apply to the foreman, with the result, in many cases, of finding the men receiving more per month than those responsible for their direction. It may be stated that overtime rates have much to do with this condition. True—but who puts in more overtime than the average subordinate official, receiving a monthly stipend? An efficient organization, under the conditions mentioned can not be built up, or maintained.

The large railroad to-day should have in its motive power department more division master mechanics, each to have allotted to him for care and maintenance, such number of locomotives as can be properly looked after, and to the extent that he may know the shortcomings and weaknesses of each individual engine and be held responsible for its performance and cost of maintenance while out of main shop. This may

require his having jurisdiction over two or more enginehouses. The main shops on each grand division to be supervised by a shop superintendent, who will be held responsible for cost per unit of shop output; each grand division to be in charge of a division superintendent of motive power; and over the entire department, an official on the staff of the president, having a thorough understanding of the department, as to its details and needs, and of sufficient knowledge and experience to present the motive power problem, and to show that it is an element in the operating problem. It is gratifying to note that one such position has recently been created on one of our more important railroads.

Another detail of organization, which is part of the motive power problem, is the establishing of systems of apprenticeship, under proper supervision, whereby the apprentice can, and will be assured a thorough, practical course of training in the shops, and for those who show the aptitude, or inclination, a special course, with the end in view of providing sufficient technical training to fit them for positions of responsibility. The apprentice of to-day is rapidly drifting out of sympathy with his employers, by reason of the indifference displayed toward him by those having him in charge. To offset this tendency he must feel that the employers have his welfare at heart and this can only be accomplished in these busy times by having an apprentice department with an official at its head, to relieve those in immediate charge. A very thorough and competent organization of this character is now in operation on the New York Central Lines.

Considerable thought and experiment has been devoted during the past year, to the development of a motor car, which could be used for branch service, corresponding to the service furnished by the interurban electric car. The most promising field of effort, has been the gasoline motor. Others have followed in the footsteps of our foreign friends and have experimented with steam, using oil for fuel. What the outcome will be, cannot be conjectured at this time. It is safe to say, however, that with the demand for such a car in sight and American ingenuity at work, a satisfactory car will be evolved in due time.

The association has before it for consideration reports of unusual interest and exceptional value.

The report of tests of locomotives at the Louisiana Purchase Exposition, terminates the work of the committee appointed in 1903, to represent this association on the Pennsylvania Railroad Company's advisory committee, and brings to your attention the conclusion of a research of unusual magnitude and value. Beginning in the spring of 1903, the Pennsylvania Railroad system designed and constructed a locomotive testing plant and equipped it with accessory apparatus of every sort. It secured the co-operation of national engineering societies in the formation of an advisory committee, which committee had an important part in the scientific phases of the work, and it made its plant accessible to other railroad companies which furnished locomotives for test. In this manner it has determined by methods carefully chosen, with the highest degree of accuracy, the performance of eight typical locomotives and has published in elaborate form, a complete description of its methods and a full record of its results. The effect of this whole process and the results developed therefrom, as factors in the upbuilding of the American locomotive of the future, are of unusual significance.

The American Railway Master Mechanics' Association may well congratulate itself, that throughout this process, it has been represented upon the Pennsylvania Company's advisory committee by three of its chosen members, who, in co-operation with other eminent engineers, have given their time and attention to the development of the various details concerned in this great work.

The report of the committee on locomotive front ends, represents the work that has been accomplished to date. The investigations thus far conducted have been thorough, and complete and have definitely settled the principles underlying the design of locomotive front ends.

Not only has the law been established connecting the size and proper proportions of the stack with the diameter of the front end thus completing the previous system of tests initiated by the AMERICAN ENGINEER, in which the proper proportions of the stack and its relation to the various positions of the nozzle was established for a 54-in. front end, but the various styles of inside stacks, false tops to the smokebox, and different arrangements of petticoats have been experimented with, resulting in definitely deciding upon the arrangement which is most satisfactory and economical in service. Sufficient data was also obtained to explain most conclusively the reasons for the large variety of results that have been obtained from time to time in practice with different arrangements of stacks and petticoat pipes. It would appear from the experiments that the work has been carried to a completion and that no further work of this nature will be required, unless it be on something totally different to the front end arrangements which have hitherto been employed.

In the successful prosecution of this work, we are indebted to the railroads for their generous contributions; to the N. Y. C. R. R., for the loan of a large locomotive, and to Dr. W. F. M. Goss, for the active part taken in the work, and it is hoped that suitable action will be taken at this convention in testimony of our indebtedness to those just mentioned.

The association has before it, in the two reports just referred to, examples of research work excellently performed, and it will do well to follow along similar lines in its future investigations. I deem it a great privilege to be your presiding officer on the occasion of the presentation of these important subjects.

The report and discussion on the subject of mechanical stokers should stimulate interest in the development of this exceedingly important detail of locomotive construction. We should know more about stokers, and the association has acted wisely in appointing a standing committee to report progress being made from year to year.

In the discussion of classification of locomotive repairs an opportunity is presented to get into the commercial questions of the department. This phase of the subject has not received the attention it deserves, and herein lies a great opportunity for motive power men.

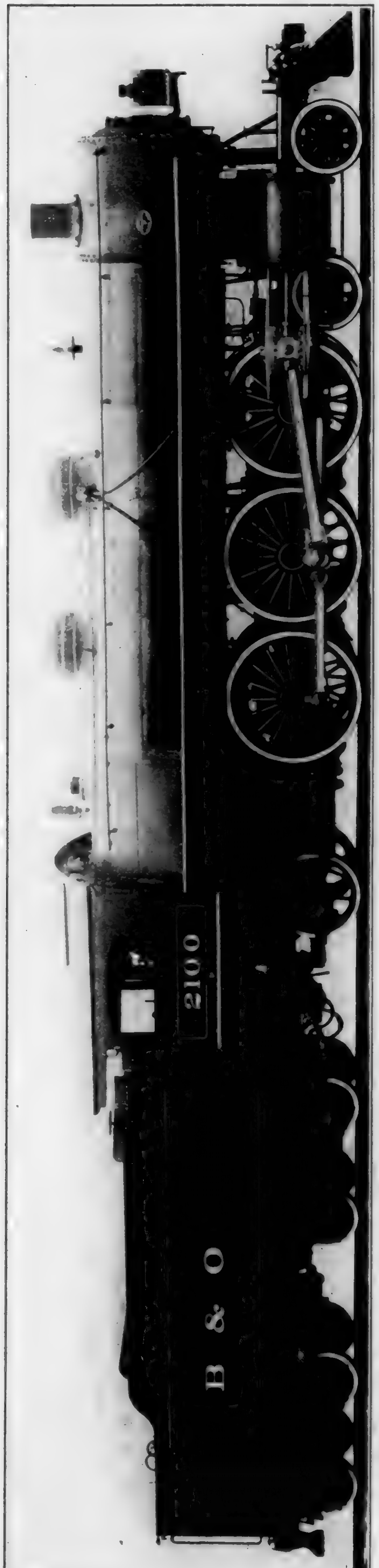
In discussing the details of enginehouse running repair work it is absolutely necessary to treat the proposition as a whole, with the view of facilitating operations at terminals to meet the needs of the operating department.

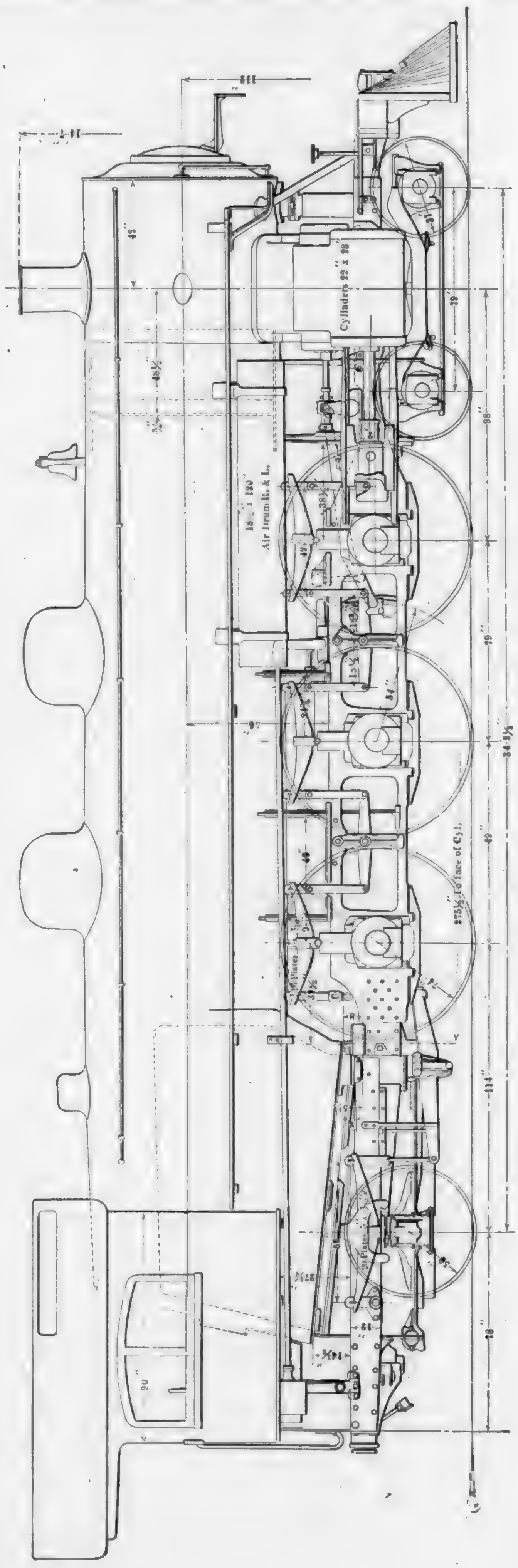
The report to be presented on the subject of "Electricity on Steam Railroads," is worthy of the most careful consideration and discussion. In view of the economy obtained in tests of the locomotive on the Pennsylvania testing plant, where it was shown that a locomotive was capable of delivering a horse power at the drawbar upon the consumption of but a trifle more than two pounds of coal per hour, the discussion of this paper should excite more than ordinary interest.

In the upbuilding process toward a higher plane of excellence of the steam locomotive, the association has for its future work the further development of the stoker, the superheater, the compound, and other details standing for lesser economies of operation, and with the end in view that their application may become general in character, the working out of a better system of statistics which will show us where we stand and put us in possession of the business facts concerning our department, making them immediately available.

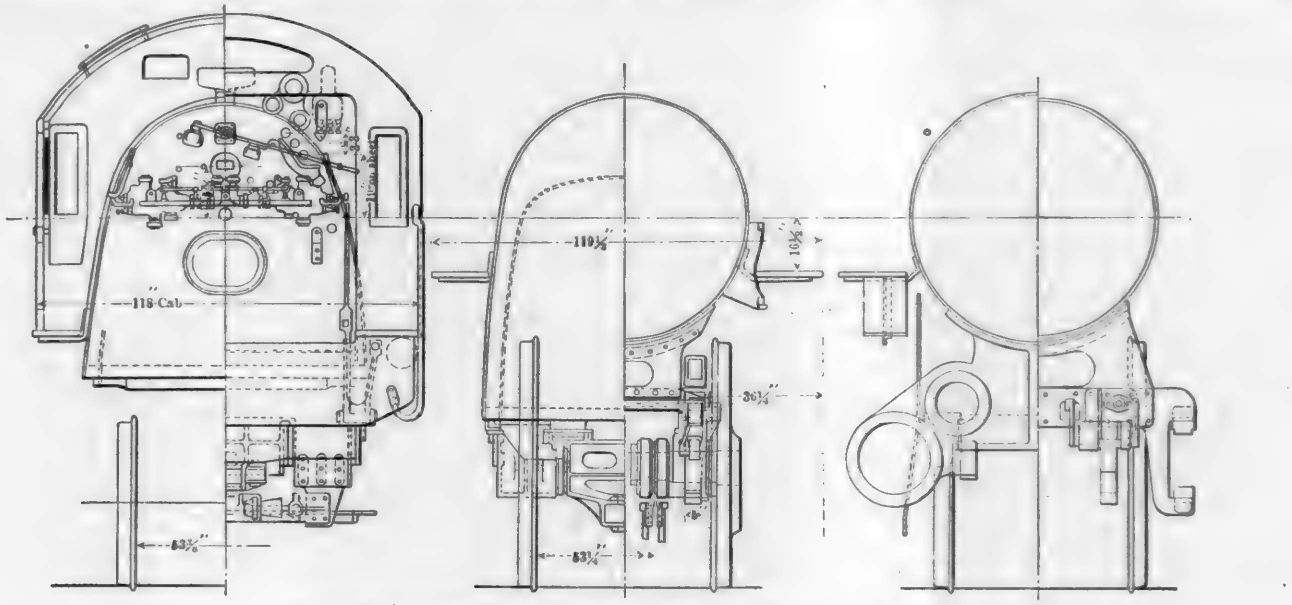
For the department as a whole the association has for future work organization, as it applies to modern shops and engine houses, up-to-date apprenticeship systems applicable to large corporations, development of motor cars for light passenger service, establishment of a bureau for scientific research work.

In connection with the latter recommendation, this association should make provision for a bureau with a salaried official at its head, to whom research work of a scientific character required of committees can be referred, through the Executive Committee. This would add value to reports and





PACIFIC TYPE PASSENGER LOCOMOTIVE—BALTIMORE & OHIO RAILROAD.



CROSS SECTIONS, PACIFIC TYPE LOCOMOTIVE—B. & O. R. R.

would relieve members of committees of a large amount of detail work to which they cannot always devote the time necessary for a thorough investigation of the subject.

The time is past when a motive power officer should be merely a good mechanic and manager of men. He must have these attributes and much more also. He is called upon to-day to be a mechanical engineer, in the design of locomotives, an executive, in the management of a great department, an organizer, in the building up of the department,—keeping it abreast of the increasing difficulties of the problems. He must be a business man, in knowing the costs of his work, and in making every dollar of the stockholders' money bring the greatest returns. He must be a diplomat in dealing with the other officials and a general in managing his subordinate officials and his men. These qualifications a man must possess in order to be an important official in any large industrial organization, but in a motive power position additional qualifications are required, which are best summed up in the statement that he must be a railroad man, ready for any and every emergency and ready to fit his work into that of others in such a way as to complete an exceedingly important corner of the organization.

In fitting our work into that of the operating department lies an opportunity, which is perhaps our greatest opportunity of the present time. Up to a certain point we can go with our own office, and up to a certain point we may introduce improvements, but beyond that point we cannot go without the heartiest co-operation of others. And it is in the direction of securing this co-operation, or in applying the operating possibilities of our positions, that our greatest future lies. That the operating officers shall consider the motive power men as their strongest supporters and most helpful allies in the difficulties of their work should be our aim, and in this direction the motive power department can undoubtedly go much farther than it has ever gone, and it is to the importance of this that I direct your attention most earnestly.

We should contribute to secure mileage of our engines always bearing in mind the fact that locomotives are not intended to make good repair records, so much as to pile up ton mileage. If the ton mileage is not always obtained the railroad machine is not working to its best advantage, and there may be good reasons for this. By helping the operating official we may find that he can help us, and in the development which tends toward the most favorable operating service lies our greatest work for the future.

Let us remember that we are not merely heads of departments. We are officials of railroads striving to increase to the utmost the net earnings, and when we have gone to the limits of our ability as mechanical men we have yet a long way to go in the direction of the operating men to improve the results. By always conducting our department so that the motive power is ready for any emergency we shall help the department, help the other officials and incidentally help ourselves. There is more before us than there is behind us in the way of improvements, and there is no work to-day lying before any class of men which is more important and more inspiring than that in which we are engaged.

BALTIMORE & OHIO RAILROAD MOTIVE POWER.

The motive power of the Baltimore & Ohio Railroad has received most substantial additions during the past three years in the shape of many new steam and electric locomotives for passenger, freight and switching service.

The most notable of these was the large Mallet compound engine, the largest locomotive in the world, which was built for the Baltimore & Ohio by the American Locomotive Company in 1904. This locomotive was thoroughly illustrated and described in the AMERICAN ENGINEER AND RAILROAD JOURNAL, 1904, pages 167, 237, 262 and 297.

Just previous to the building of the Mallet locomotive an electric freight locomotive, consisting of two coupled units, was built by the General Electric Company for the same road. This locomotive is nearly as heavy and powerful as the above-mentioned steam engine, and was illustrated in this journal in September, 1903, page 324. A comparison of the operation and maintenance of these two locomotives was given in a paper by Mr. Muhlfeld before the New York Railroad Club in March of the present year. Extracts from this paper and Mr. Muhlfeld's remarks at the meeting will be found in this journal of March, 1906, page 101, and in this issue.

In addition to these special locomotives, which have proven to be most successful in the work for which they were designed, a large number of standard types have been purchased. These include some very heavy consolidation locomotives built by the American Locomotive Company, which were illustrated and described by Mr. Muhlfeld in the AMERICAN ENGINEER AND RAILROAD JOURNAL for January, 1906, page 29, and some heavy six-wheel switching engines built by the Baldwin Locomotive Works, the general dimensions of which are given in the table herewith.

The latest addition to the locomotive equipment consists of some very heavy and powerful Pacific type engines built by the American Locomotive Company, which are illustrated herewith. These rank with the heaviest, and are the most powerful of any of this type on our record. They have 22 by 28-in. cylinders, 74-in. wheels and 225 lbs. steam pressure, which gives them a tractive effort of over 35,000 lbs. The

MALLET ARTICULATED LOCOMOTIVE.

ELECTRIC LOCOMOTIVE.—TWO-SECTION EIGHT-WHEEL FREIGHT.

total weight is 229,500 lbs., of which 150,000 lbs., or 65.7 per cent., is on drivers.

The accompanying table and illustrations give a clear idea of the size and construction of these locomotives.

Mr. Muhlfeld, superintendent of motive power, states that they were particularly designed for the handling of heavy through passenger trains at the required speeds over level and mountainous, open and tunnelled railroad, of varying curvature and gradient, and that especial attention was given to the following features:

A design of motion gear that would provide for the quick

SIX-WHEEL SWITCHING LOCOMOTIVE.

starting and acceleration of trains, so that the schedule time could be maintained, or time made up without the use of helper locomotives on heavy grades and curvature, or the necessity for unusually fast running on down grades;

The greatest proportion of adhesive to total weight of engine and tender in working order;

A substantial construction of the least number of parts;

A capacity to perform continuous service without liability for failure, and economy with respect to maintenance and fuel and water consumption.

A boiler of simple design and substantial construction, with ample grate area in one plane and firebox heating surface, together with provision for a circulation of water and unrestricted passage of gases, and suitable for the consumption of a cheap grade of either gas or soft run-of-mine bituminous coals. Especial attention was given to insure dry steam at the valve chest and cylinders by the design and location of crown sheet, steam space, throttle valve opening and surge plates.

A cylinder, frame, running and motion gears, and general design that would permit of increasing the weight and tractive power of the locomotive when the boiler tubes, tires, cab, running boards, lagging, jacketting, grates, ash pan and other similar parts require replacement, due to ordinary wear and tear, and at the same time allow for a reduction of the boiler pressure should age and general depreciation of the boiler necessitate it without the renewal of any parts not entirely worn out or destroyed.

The same details of design, construction and material as specified for the consolidation locomotives were embodied in the Pacifics, so far as practicable, in order to insure the greatest interchangeability of parts between these, and the older classes of locomotives in service, as could be done without the continuance of obsolete or unsatisfactory details, which would not provide for the greatest economy in maintenance and performance.

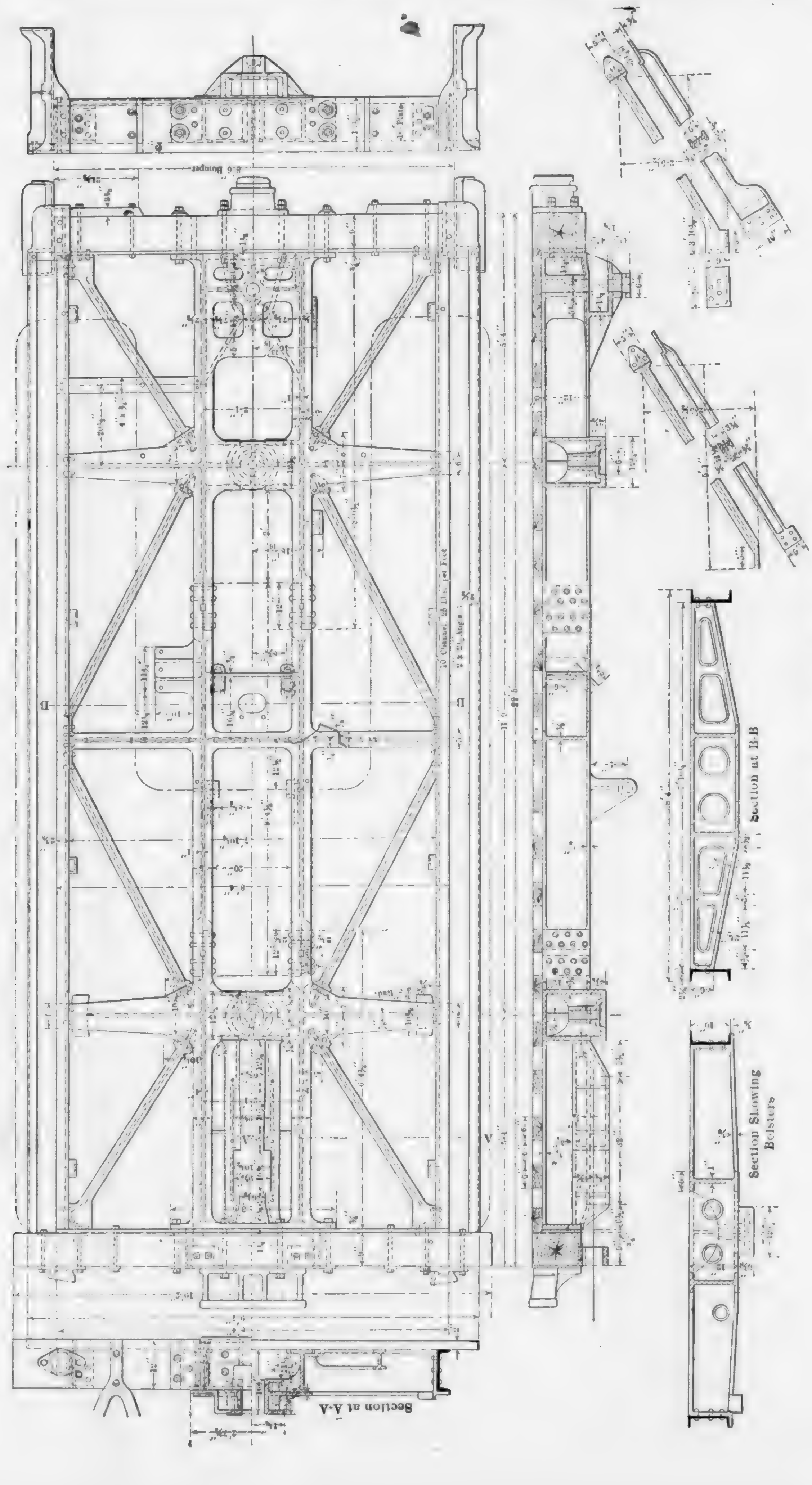
These passenger locomotives are now in regular service, and haul, without a helper, through passenger trains, consisting of 1 baggage, 1 postal, 2 vestibule coaches, 1 dining, 3 sleeping and 1 observation parlor car, or a total of 9 cars, approximating 425 tons, for a distance of 31.6 miles from Cumberland,

STEAM AND ELECTRIC LOCOMOTIVES, BALTIMORE AND OHIO RAILROAD.

Class	0-6-6-0	2-8-0	0-6-0	4-6-2	0-8-8-0	0-4-4-0
Type	Mallet Articulated	Consol.	6-Wheel	Pacific	Two-Sec. 8-Wheel	Two-unit 4-Wheel
Service	Freight	Freight.	Switching	Passenger	Freight	Passenger
Fuel	Bit. Coal	Bit. coal	Anth. Culm	Bit. coal	625D. C.	625D. C.
Tractive effort	74,600	42,168	29,740	35,020	70,000	42,000
Tractive effort starting	84,000				80,000	49,000
Weight in working order	334,500	208,500	161,080	229,500	320,000	196,000
Weight on drivers	334,500	185,900	161,080	150,500	320,000	196,000
Weight on leading truck		22,600		40,500		
Weight on trailing truck				38,500		
Weight of engine and tender in working order	479,500	352,000	246,080	376,500		
Wheel base, driving	10 ft. 0 in.	16 ft. 8 in.	11 ft. 0 in.	13 ft. 2 in.	14 ft. 6¾ in.	6 ft. 10 in.
Wheel base, total	30 ft. 8 in.	25 ft. 7 in.	11 ft. 0 in.	34 ft. 3½ in.	44 ft. 2¾ in.	23 ft. ¾ in.
Wheel base, engine and tender	64 ft. 7 in.	59 ft. 8¼ in.	40 ft. 9½ in.	65 ft. 6¾ in.		
RATIOS.						
Weight on drivers ÷ tractive effort	4	4.4	5.4	4.3	4	4
Total weight ÷ tractive effort	4	4.95	5.4	6.55	4	4
Tractive effort x diam. drivers ÷ heating surface	740	905	935	760		
Total heating surface ÷ grate area	77.5	49.5	22.4	60.5		
Firebox heating surface ÷ total heating surface	3.92	6.4	10.5	5.23		
Weight on drivers ÷ by total heating surface	59.7	66.2	98	44		
Total weight ÷ total heating surface	59.7	74.5	98	66.5		
Volume both cylinders, cu. ft.	18.75	13.2	9.2	12.3		
Total heating surface ÷ vol. cylinders	298	211	179	278		
Grate area ÷ vol. cylinders	4.17	4.25	7.95	4.56		
CYLINDERS.						
Simple or Compound	Compound	Simple	Simple	Simple		
Type of compound	Mellin					
Diam. high or simple	20 in.	22 in.	19 in.	22 in.		
Diam., low	32 in.					
Stroke	32 in.	30 in.	28 in.	28 in.		
Number of Cylinders	4	2	2	2		
VALVES.						
Type of gear	Walschaert	Stephenson indirect.	Stephenson indirect.	Stephenson direct.		
Kind of valves	H.P. 10 in. piston L.P. slide-double ports.	Balanced Slide.	Balanced Slide.	Inside admission piston		
Greatest travel	6 in.	6 in.	5 7/16 in.	6 in.		
Outside lap	H.P. 1¼ in. L.P. 1 in.	1¼ in.	¾ in.	L—L		
Inside clearance	H.P. ¼ in. L.P. ¼ in.	⅛ in.	1/32 in.	1 in.		
Lead in full gear	H.P. ⅛ in. L.P. ⅛ in.	1/16 in.	1/16 in.	1/16 in.		
No. of driving wheels	12	8	6	6	16	8
Diameter	56 in.	60 in.	52 in.	74 in.	42 in.	62 in.
Diam. of truck wheel		33 in.		37 in.		
Diam. of trailing wheels				50 in.		
BOILER.						
Style	Str. top.	Str. top.	Wooten	Str. top.		
Working pressure	235	205	180	225		
Outside diameter of first ring	84 in.	74 7/16 in.	70 in.	72 in.		
Firebox, length and width	108⅛ in.	108⅛ in.	110 in.	108⅜ in.		
Firebox plates, thickness	96¼ in.	75¼ in.	96 in.	75¼ in.		
Tubes, number	436	282	229	276		
Tubes, outside diameter	2¼ in.	2¼ in.	2¼ in.	2¼ in.		
Tubes, length	21 ft. 0 in.	15 ft. 10 in.	11 ft. 6 in.	20 ft. 0 in.		
Heating surface, firebox	220.0	179.4	172.84	179.4		
Heating surface, tubes, water sides	5380.0	2612.8	1476.67	3234.6		
Heating Surface, total	5600.0	2792.2	1649.5	3414.0		
Grate area	72.20	56.24	73.33	56.24		
Height center of boiler above rail	10 ft. 0 in.	9 ft. 10 in.	8 ft. 9 in.	9 ft. 4 in.		
Extreme height above rail	15 ft. 0½ in.	14 ft. 10 in.	14 ft. 11¼ in.	14 ft. 7 in.	15 ft. 0 in.	14 ft. 7½ in.
TENDER.						
Type	Water bottom	Water bottom	U sloping back	Water bottom.		
Coal, tons	16	15	6	15		
Water (U. S. Gals.)	7,000	7,000	4,000	7,000		
H.P. at 10 M. P. H. behind tender	2,096	1,124	686	924	2,096	1,410
Tons of loads capable of hauling at 10 M. P. H. on 1 per cent. grade	2,200	1,180	720	970	2,200	1,480

Md., to Manila, Pa., near the crest of the Allegheny Mountains, the total rise in altitude being 1,588 ft., in 63 minutes. This distance is made up of an average gradient of 4 per cent. between Cumberland and Hyndman, a distance of 13.9 miles, and of 1.4 per cent. between Hyndman and Manila, a distance of 17.6 miles, run on a 1.5 per cent. grade with 8 deg. reverse curvature between Roddy and Manila, and a 1.5 mile on a 1.93 per cent. grade. They are also hauling passenger trains consisting of 11 cars and approximating 500 tons from a dead stop for a distance of 7 miles on a 1 per cent. grade with from 1 to 8½ deg. curvature in 14½ minutes.

The table of dimensions also includes the electric passenger locomotives purchased about 10 years ago, which have a total weight of 196,000 lbs., and a tractive effort of 42,000 lbs. These have been and are in successful operation, and are of particular interest in connection with the electric passenger locomotives now being built for the New York Central and New York, New Haven & Hartford railroads.



CAST STEEL TENDER FRAME—CENTRAL RAILROAD OF NEW JERSEY.

CAST STEEL TENDER FRAME.

CENTRAL RAILROAD OF NEW JERSEY.

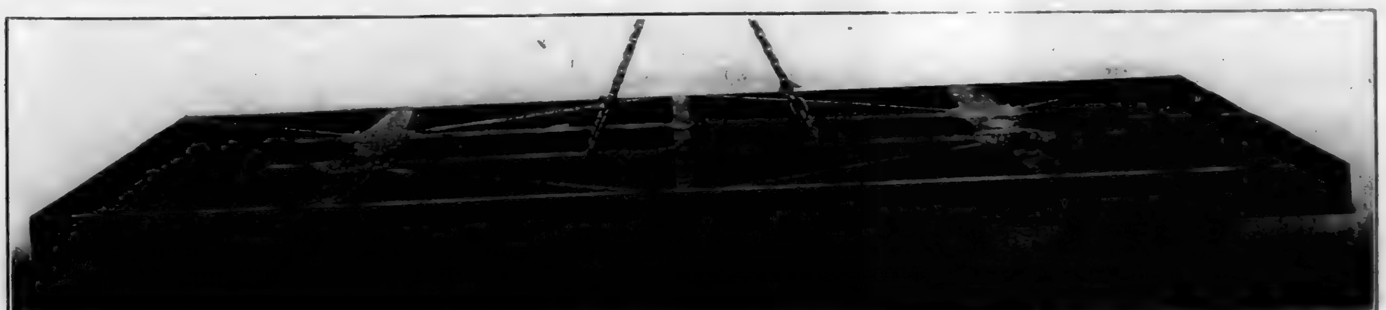
The Central Railroad of New Jersey has recently put into service several tender frames of the design illustrated herewith, which from the standpoint of simplicity, strength and rigidity are undoubtedly an improvement over the usual structural steel design.

This frame is made principally of cast steel and comprises, exclusive of the bumpers, floor and attachments, but 13 separate parts of which 11 are cast steel. The three largest of these castings form the main part of the frame, including the center sills, bolsters, draft casting and the cross support in the centre. The other eight cast steel parts comprise the diagonal braces the location of which is clearly shown in the illustration. The joints between the three principal castings are made just inside the bolsters at points most convenient for casting and the clearance of attachments.

CAST STEEL TENDER FRAME—THREE MAIN CASTINGS FITTED.

The "I" section has been used throughout and much care was given to eliminate any large masses of metal at any single point and except at the joints between the castings and diagonally across the junctions there is no section thicker than one inch.

The center sills are 12 ins. deep with a 1-in. web and a 5 in. flange and the side sills are 10 in. channels securely riveted to the castings at the bolsters, corners, etc. The draft attachments at either end are cast integral with the sills and made amply strong by the proper location of numerous webs and flanges. Side bearings are cast on the rear bolster only as is the practice on tender frames on this road. The drawings and photographs clearly show the details and general appearance of this interesting design. The lugs and projections noticed on the centre castings are for attaching a water scoop and the auxiliary reservoir.



CAST STEEL TENDER FRAME COMPLETE.

Contrary to what might be expected this frame is lighter than a built up steel frame of equal or less strength, as is shown by comparing it to such a frame on the Central Railroad of New Jersey, which is 15½ ins. shorter. The weights of each complete are as follows:

Cast steel frame—11,757 lbs.

Structural steel frame—11,980 lbs.

The essential features of this design have been patented. We are indebted to Superintendent of Motive Power William McIntosh for the illustrations and information. The frame was designed in the drawing room of the Jersey Central under the direction of Mr. B. P. Flory, mechanical engineer.

One of these frames arranged with a transom draft gear was exhibited at the Atlantic City conventions by the Commonwealth Steel Company, who made the castings for all the frames.

RAILROADS AND THE TIMBER PROBLEM.—A railroad should have a man who can deal with timber in its broadest sense. I do not mean a purchasing agent, but a technical man, who should have a position equivalent to the consulting engineer, reporting to the vice-president or general manager. He should be able to deal with forest lands in their relation to railroad supplies, with timber inspection, handling, treatment, and its final disposition. He should have authority to make investigations with competent assistants so as to keep himself posted as to changes in methods, as to timber values, maintenance problems, etc., and his opinion should be that of an expert. So far as I know, only one railroad has so far created a position of manager of a tie and timber department in the sense indicated. It is particularly striking that this should be the Atchison, Topeka and Santa Fe Railroad, a road with the largest experience in timber treating of any in this country. The example which they have set should be followed by others.—*Dr. Hermann von Schrenk, American Forest Congress.*

THE MOTIVE POWER PROBLEM.—This is the locomotive problem for the immediate future—to provide more power without greatly increasing existing weights. A secondary, but scarcely less important field for effort, is the improvement of design and method of operation which will reduce road service failures. Another opportunity for the greatest abilities lies in revolutionizing methods of motive power management to bring them into parallel with those methods which have brought the greatest successes in the management of vast industrial establishments. Altogether the motive power problem presents possibilities as great as those of any field of mechanical activity, and these are worthy of the efforts of the best of men.—*Mr. G. M. Basford, at Purdue University.*

COMBINATION STEEL AND WOOD PASSENGER CAR

The Southern Railway is having three combination steel and wood passenger cars built at the works of the Pressed Steel Car Company, one of which was exhibited at the Master Mechanics' and Master Car Builders' conventions at Atlantic City. The leading dimensions of the car are as follows:

Length over platforms	74 ft.	6¼ ins.
Length over body end sills	66 "	0 "
Total inside length	65 "	3¼ "
Distance from center to center of trucks	50 "	0 "
Width over side sheets	9 "	10¼ "
Width inside between finish	8 "	10¾ "
Height from top of rail to top of body	14 "	2 "

The size of the car and the interior arrangement and equipment correspond as nearly as possible to the Railway Company's standard coach. The underframe, framing, platforms, covered with special drawn steel moldings, which give the appearance of the broad panels used on wooden cars. Because of using the Railway Company's standard six-wheel trucks with standard height of bolsters and center plates, it was impossible to make the depth of the bolsters and center sills over the trucks sufficient to bring the center line of the draft gear above the lower edges of the center sills.

The floor is composed of ⅛-in. steel plates, upon which are laid two courses of wooden flooring, each ¼ in. thick with ⅛-in. felt paper between. The top of the floor is covered with 3-16-in. linoleum.

The design of these cars was worked up by the Pressed Steel Car Company subject to the approval of Mr. A. Stewart, mechanical superintendent, and Mr. R. L. Ettinger, consulting mechanical engineer of the Southern Railway. The use of

COMBINATION WOOD AND STEEL PASSENGER CAR FOR THE SOUTHERN RAILWAY.

platform sills, body carlines, and the side sheets on the outside below the windows are made of steel in the form of plates and pressed, rolled or built up parts, depending on the requirements. The interior finish, doors, windows, window sash, upper part of the floor, roof and the outside above the window sills are of wood.

The underframe is composed of two fish-belly center sills built up of ⅜-in. plates, 22 ins. deep at the center and 13⅛ ins. over the bolster. These plates are reinforced with angle irons and cover plates, and extend the length of the car between the platform sills. The body bolsters are double, spaced to suit six-wheel trucks, and consist of 7-16-in. plates 13⅛ ins. deep near the center sills, tapering toward the sides and reinforced with T-irons and cover plates on top and bottom. The side bearings are supported on 8-in. I-beams, secured between the two parts of the bolster.

The underframe has two deep and eight shallow diaphragms on each side of the car between the bolsters. The deep diaphragms consist of ¼-in. plates, 20½ ins. deep at the center sills, and are reinforced with T-irons and cover plates on top and bottom. The shallow diaphragms consist of 7-in. channels. The side plates below the windows are 3-16 in. thick of cold-rolled steel, reinforced with angle irons at the bottom edge, and with a special shape at the top edge under the window sill. Both of these reinforcing members extend the full length of the body.

The main posts consist of two angles spaced apart, and the intermediate posts are T-irons. The main posts extend from the bottom of the side plate to the roof, but the intermediate posts extend from the roof to the window sill only, at which point they are riveted to a reinforcing plate extending between the main posts inside of the side sheets. The framing at the ends consists of angles at the corners and of three channels reinforced with plates on each side of the door. The platforms are supported on the center sills and on 6-in. channels. The platform end sills are pressed of 5-16-in. steel plate into channel shape and to suit the vestibule fixtures.

All vertical lines of rivets on the outside of the car are steel adds greatly to the strength of the car, and thus to the safety of the passengers in case of accident. It is one of the first passenger coaches of this type built for use on steam roads, and while future cars will undoubtedly be changed more or less it is a decided improvement in the right direction. It is understood that the Pressed Steel Car Company is at the present time working on designs of several types of steel passenger coaches with steel trucks which will be entirely fireproof.

THIRD RAIL CLEARANCES.

Mr. F. M. Whyte, general mechanical engineer of the New York Central Lines, on behalf of a committee which was appointed to investigate the question of third-rail clearances, at the recent meeting of the Master Car Builders' Association, made the following verbal report outlining a written report which is to be submitted in time for publication in the proceedings:

As I understand it, the object of bringing this matter to the attention of the Association is to get in the records of the Association the dimensions for third-rail clearances, not only that, but to present to the Association some peculiar conditions which might be overlooked by the members.

In the first place, the third-rail location, particular location, depends upon several things. So far as power and locomotive work is concerned, the further out the third rail the better, but for various reasons it can be located too far for successful operation. At switches and cross-overs there is necessarily a gap in the third rail; that is, there is either a "dead point" or overhead construction is provided to carry the equipment over the gap. The further the third rail is from the running rail, the longer these gaps, and at places the gaps are too long for the length of locomotive which is now used or we are preparing to use, and in some cases even longer than the ordinary suburban train would extend. So on this account it is desirable to keep the third rail reasonably close to the running rail. Also, there are a good many truss bridges

all ready on the right of way, and the gusset plates for these are so located that the third rail might interfere with them if placed beyond something like the present limits, 28 or 30 ins. The passenger station platforms also would be affected; and, of course, if the third rail is moved further away the shoes on the trucks must be carried out to meet it, and it is best that these shoes should not project any further than is really necessary. These are some of the things that need to be considered in locating the rail horizontally with respect to the running rail. Vertically, it is desirable to keep the rail as low as possible, and if it were possible the top of the third rail should be located flush with the top of the running rail. There are two kinds of third rail, one the over-running, with the shoe on top of the rail, the other the under-running, with the shoe beneath the rail, and with the over-running rail there is a pressure which carries the shoe down. As the shoe runs off the third rail, the pressure still carries the shoe somewhat lower, so that it is necessary to keep the third rail a sufficient distance above the running rail to allow for this additional depression of the shoe and still permit the shoe to cross frogs, turn-outs, switches, etc. With the under-running rail the shoe would rise up on leaving the third rail, and clear these other rails better; but there must be clearance, of course, between the top of the track rail and the inside of the third rail for the thickness of the shoe. As I recall the figure now, the difference in height is 3½ ins., and that is not great, considering allowances for the spring motion of the shoe itself. These are the conditions which locate the third rail vertically.

As to the clearance diagram of the third rail, or that part of the clearance diagram relating to the third rail, that must be considered in a different light from the remaining part of the clearance diagram. The third rail is located the same distance from the running rail on curves as on tangents. The shoes are on the trucks, and therefore do not offset with the curvature, so that in car and locomotive work we must keep far enough inside the third-rail diagram to allow for curvature. The rest of the diagram is provided for by the engineering department, that is, above the third rail. If there are obstructions at curves, they are set back far enough to allow for the offset of cars, but in third-rail work that is impossible, or considered so thus far. The distance which truss rod bearers, battery boxes and other attachments to passenger cars and freight cars should be carried in from the third-rail clearances will depend upon the wheel base of the car, or the distance between truck centers, I should say. With a 56-ft. truck center the offset on a 20-deg. curve is about 17 ins. I speak of a 20-deg. curve, because that is the sharpest curve which the New York Central expects to use in their through yard as distinguished from the suburban yard.

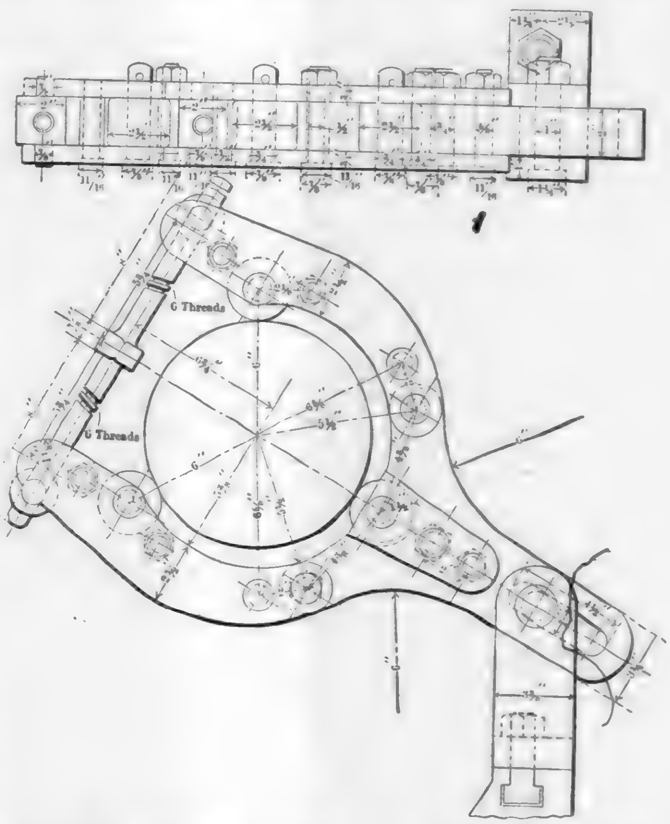
I think it would be the intention of the committee to include in the report the clearance diagrams of those roads which now have some third rail located, and call attention to those particular features which should be observed by those who care to construct their equipment so that it will clear the third rail.

ADVICE TO YOUNG MEN ENTERING THE MOTIVE POWER DEPARTMENT.—Without in any way reflecting upon the opportunities offered in the line of mechanical engineering work, it should be said that experience either in the shops or in the roundhouse is important for a young man who is to succeed. It seems desirable to positively recommend young men to delay entering the engineering work until they have had experience in one or both of the other branches. If they are by temperament and ability qualified for either shop or road administration, they will learn this fact most easily and quickly in connection with the actual work, and if they are better fitted for engineering problems, they will be better able to handle them later on because of the road or shop experience. It seems, in general, desirable for most young men to avoid the drafting room immediately on completion of their college work, and it is believed that in this most railroad officials will agree.—*Mr. G. M. Basford, at Purdue University.*

ROLLER FOR DRIVING JOURNALS.

It has been the custom in many railroad shops to roll the journals of locomotive driving axles, after they have been machined, for the purpose of giving as smooth a surface as possible and reducing the tendency to heat at the start. The tool for doing this, in many cases, consists simply of a hardened steel roller mounted in a yoke, which is set into the tool post of the axle lathe, and the pressure for rolling is obtained by tightening up on the cross feed of the carriage. Inasmuch as satisfactory results require sufficient pressure to crush the inequalities left by the turning tool on the journal, this single roller method places a very heavy strain on the lathe carriage, and at the best requires a considerable length of time to obtain a smooth surface.

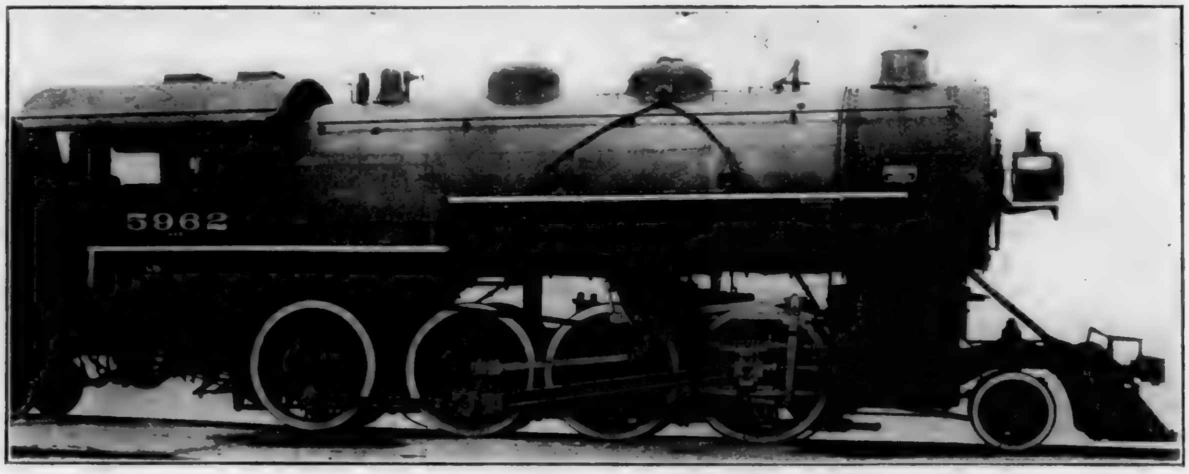
We illustrate herewith a device which has been designed and is in use at the Columbus shops of the Pennsylvania Lines west of Pittsburgh, which not only eliminates the objection of the stresses on the tool post, but also permits a much heavier pressure of the rollers against the journal, thus giving a better result in shorter time. This tool as can be



seen in the illustration, employs three rollers set at equal distances around the journal, two of them being mounted upon swinging arms, which are hinged at their inner ends to a yoke containing the third roller and reaching to a connection on the lathe carriage. The outer ends of these arms are drawn together by a double-threaded bolt. It is easily recognized that when this tool is in place (which operation is easily performed, since one end of the tightening screw block fits into a notch in the swinging arm on that end and can be released and swung downward, to allow the whole yoke to be placed around the axle) there is only a downward strain, due to the resistance of the rollers in revolving, placed upon the lathe carriage.

The rollers, which are of hardened steel, have a diameter of 2½ ins. and a length of 2 ins., and run between a framework consisting of ¾-in. iron, the two sides being spaced and connected by bolts and thimbles at the proper points.

"And it is the minute of talk after the hour of thought, the ounce of effort after the ton of preparation, that steers a business project into the harbor of success."



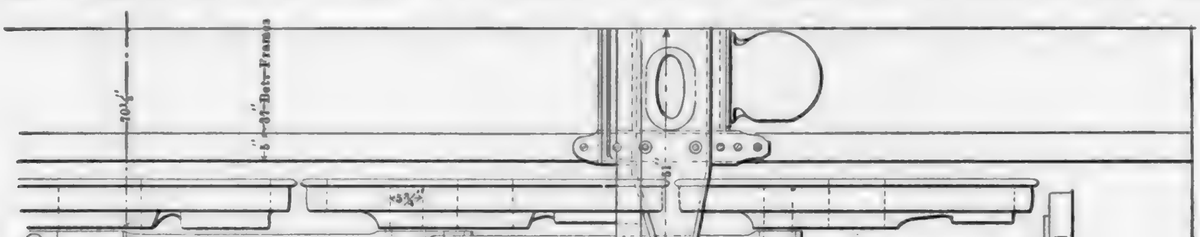
SIMPLE CONSOLIDATION LOCOMOTIVE WITH WALSCHAERT VALVE GEAR—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

SIMPLE CONSOLIDATION LOCOMOTIVE WITH WALSCHAERT VALVE GEAR.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

Somewhat over a year ago the Lake Shore & Michigan Southern Railway put into service some very heavy consolidation locomotives equipped with Walschaert valve gear, which were illustrated in this journal in February, 1905, page 46. The experienced gained in the operation of those engines has lead to a redesign of this part for use on an order of very similar engines which have recently been put into service and are illustrated herewith.

The illustrations show this new design so clearly that it needs but little explanation, and by reference to them it will be seen that the support for the small crosshead connecting to the valve stem has been placed on an entirely separate guide, which is fastened to the back valve chamber head and through a link to the guide yoke instead of having it supported directly from the main guide, as in the previous design. The bearings for the reverse shaft and the link have been placed near together in the same casting and the radius arm of the valve gear is operated through a hanger from the arm of the reverse shaft instead of a sliding joint, as was used before when the reverse shaft was suported in a bearing on the frame between the second and third pair of drivers. The link itself has been made somewhat larger and more bearing surface given to the block. The casting forming these bearings is fastened to a massive but not excessively heavy steel casting extending across the frame. The construction of this casting and its dimensions are clearly shown in the illustration. To this is also fastened the yoke supporting the main guides. Another change is also noticed in that the arm from the reverse shaft, to which is connected the reach rod, extends downward instead of upward. This necessitates the reach rod being placed outside the driving wheels and on an incline from the



PLAN AND SIDE ELEVATION SHOWING WALSCHAERT VALVE GEAR—L. S. & M. S. CONSOLIDATION LOCOMOTIVE.

reverse lever. It is supported and steadied by a guide at the throat sheet. A change has also been made in the return crank connection at the main pin for the purpose of permitting it to be more quickly and easily removed, as it has to be whenever the rods have to be taken down. While the construction at the guide yoke appears to be very heavy and cumbersome, a careful examination of the drawings will show that it is really more simple than the previous design, which was a more open one.

The application of the Walschaert valve gear to this new order of engines after over a year's trial in service can be accepted as evidence that it has proved in general to be satisfactory and that the disadvantages which have been claimed to be inherent with the design have not been found after careful trial to be great enough to overcome its many evident advantages.

For other features of these very large engines reference can be made to the descriptions of the previous similar locomotives built for the Lake Shore and the New York Central in the AMERICAN ENGINEER AND RAILROAD JOURNAL, February, 1905, page 46, and January, 1904, page 16. The general dimensions, weights and ratios are as follows:

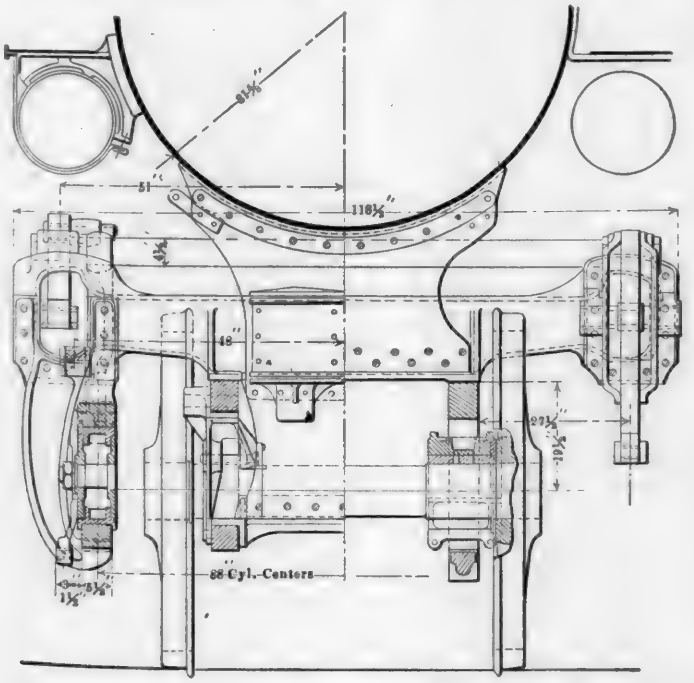
SIMPLE CONSOLIDATION LOCOMOTIVE, LAKE SHORE AND MICHIGAN SOUTHERN.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Freight
Fuel	Bit. coal.
Tractive power	45,677 lbs.
Weight in working order	232,500 lbs.
Weight on drivers	207,000 lbs.
Weight on leading truck	25,500 lbs.
Weight of engine and tender in working order	382,100 lbs.
Wheel base, driving	17 ft. 6 in.
Wheel base, total	26 ft. 8 ins.
Wheel base, engine and tender	60 ft. 9½ ins.

RATIOS.

Weight on drivers ÷ tractive effort	4.5
Total weight ÷ tractive effort	5.1
Tractive effort x diam. drivers ÷ heating surface	775
Total heating surface ÷ grate area	65.8



L. S. & M. S. CONSOLIDATION LOCOMOTIVE—SECTIONAL ELEVATION NEAR GUIDE YOKE.

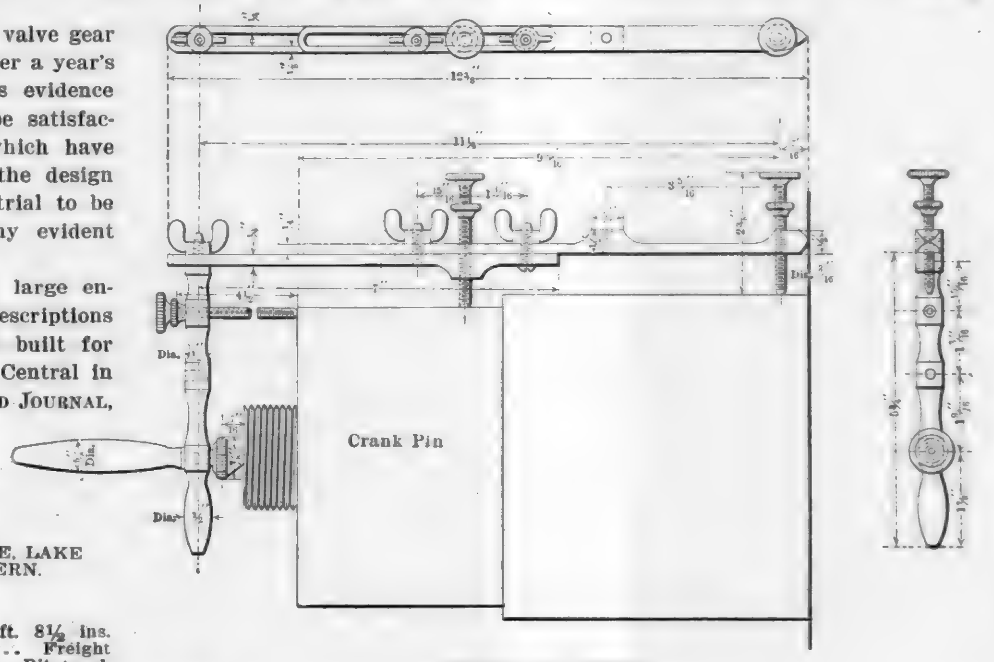
Firebox heating surface ÷ tube heating surface	6.1%
Weight on drivers ÷ total heating surface	56
Total weight ÷ total heating surface	62.8
Volume both cylinders	15.4 cu. ft.
Total heating surface ÷ vol. cylinders	240
Grate area ÷ vol. cylinders	3.66

CYLINDERS.

Kind	Simple.
Diameter and stroke	23 x 32 ins.

VALVES.

Kind	Piston
Diameter	14 ins.
Greatest travel	5¼ ins.
Outside lap	1⅛ in.
Inside clearance	0 in.
Lead in full gear	17/64 in.



CRANK PIN TESTER.

WHEELS.

Driving, diameter over tires	63 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	10 x 12 ins.
Driving journals, others, diameter and length	9½ x 12 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	6 x 12 ins.

BOILER.

Style	Radial Stayed
Working pressure	200 lbs.
Outside diameter of first ring	81⅝ ins.
Firebox, length and width	108½ x 75¼ ins.
Firebox plates, thickness	⅝ and ⅜ in.
Firebox, water space	4½ ins.
Tubes, number and outside diameter	446-2 in.
Tubes, length	15 ft. ⅛ in.
Heating surface, tubes	3492.18 sq. ft.
Heating surface, firebox	185.64 sq. ft.
Heating surface, arch tubes	27.41 sq. ft.
Heating surface total	3705.23 sq. ft.
Grate area	56.5 sq. ft.
Smokestack, diameter	20 ins.
Smokestack, height above rail	14 ft. 9½ ins.

TENDER.

Tank	Water bottom
Frame	13 in. channel
Wheels, diameter	33 ins.
Water capacity	7,500 gals.
Coal capacity	12 tons.

CRANK PIN TESTER.

A simple device for testing crank pins to see whether they are bent or worn out of round is shown in the accompanying illustration. The device is applied to the crank pin, as shown, and by simply revolving it about the pin it may readily be seen whether it is bent or worn out or true. We are indebted to Mr. William Hall, foreman of the Chicago & Northwestern shops at Escanaba, Mich., for the drawing and information.

Roundhouse doors should be made of non-corrosive material; they should be easily operated, fit snugly, be easily repaired and maintained, and should not be exposed to damage by wind, directly or indirectly, and should admit of the use of small doors. The particular kind of door that will suit a given case can be determined only by giving proper value to the different factors enumerated above.—*Committee report, American Railway Engineering and Maintenance of Way Association.*

STEAM VS. ELECTRIC LOCOMOTIVES.

In presenting his paper on "Large Steam and Electric Locomotives," extracts of which were given in our March issue, Mr. Muhlfeld gave the following general conclusions drawn from the experience detailed in the paper:

At this period, when changes in alignment and gradient, and reconstruction of old as well as the construction of new steam railroad lines, are being considered, there is every opportunity for motive power engineers to demonstrate the advantages of electric over steam traction.

Some of the mountainous steam railroads present many attractions in the way of permanent and concentrated supplies of cheap coal, gas, oil or water for power, and water for condensing and cooling purposes, which in combination with suitable means for generating, conveying and utilizing electric current for locomotive traction power, might enable a profitable continuance of lines which are now being abandoned, or which, under the present operating conditions, must sooner or later be replaced at a very great cost.

However, before electricity can supersede steam for tonnage service, it must be demonstrated practically from actual installation and operation, and not theoretically, that the results which electrical engineers are predicting will be forthcoming, as railroads are not generally making heavy expenditures to increase the business and revenue and reduce operating expenses unless they have reasonable assurance of the net results.

It has been said that for the handling of heavy tonnage electric locomotives have extreme advantages; especially on heavy grades, in regard to speed; this on account of the steam locomotive not having the same endurance due to a limited supply of steam.

Up to the present time, from actual performance, it has not been found that electric locomotives having almost equivalent tractive power, when handling heavy tonnage on severe grades and curvature, can operate at greater speed than steam locomotives.

Of six geared and gearless electric locomotives now in service or under construction all are different in design, system or method of controlling, and there is every indication that none have yet practically demonstrated that they can meet the requirements for efficient and economical operation and maintenance.

Should it be necessary, from an electrical standpoint, to continue the use of gearing between the motors and driver wheels, as well as the large number of small diameter driver wheels, for heavy tonnage electric locomotives, to obtain the requisite tractive power, it would be interesting to know how the predicted largely increased speed, as compared with steam locomotives, is to be obtained with a reasonable efficiency and maintenance cost.

The arrangement of the propelling gear on the electric locomotives recently purchased by the Valtellina Line in Italy, is one that appeals to motive power people who have experienced difficulty with other types of electric locomotives now in service.

The working capacity of an electric locomotive having a total weight of 160 tons, with 42-in. diameter driver wheels, at a speed of 10 miles per hour on 1 per cent. grade, is about 1,500 tons in the train, excluding the locomotive. The working capacity of a steam locomotive having a weight of 167 tons for the engine and an average weight of 58 tons for the tender, with 57-in. diameter driver wheels, at a speed of 10 miles per hour, on 1 per cent. grade, is about 2,200 tons in the train, excluding the weight of the engine and tender.

In no instance when operating a steam locomotive of the above capacity under the most severe conditions has it been found that the boiler could not furnish all the steam required to develop the maximum tractive power of the engine.

Comparing the horse power developed, it has been found that the first cost, cost for operation and maintenance, number of and weight on driver wheels, and number of large bearings requiring lubrication, has, for the electric locomotive, been in excess of that of the steam locomotive, and there has been no benefit with respect to increased average sped on 1 per cent. grade.

A steam locomotive in one section can be designed and placed under the control of one engineer and one fireman, which will economically develop as much tractive power as may be necessary to haul the greatest amount of tonnage that can be concentrated in one train of suitable size for safe and quick handling over a division.

The advantage of the electric locomotive for the handling of heavy tonnage would be in the increasing of the capacity of the line, and it might be that the increased business handled would justify an increased cost for installation and operation of electric locomotives as compared with steam locomotives.

When compared with ordinary modern steam locomotives the advantage that the electric locomotives have are on account of no tender for coal and water, which reduces the average dead weight about 60 tons per train, which is equivalent to one car and about 40 tons paying load per train, providing the same drawbar pull can be obtained per equivalent horse power and factor of adhesion, when compared with steam locomotives. Electric locomotives will give the advantage of a high average speed obtained for the same weight on driver wheels, while the more rapid acceleration and a lower maximum speed results in less total power required to drive the train and a lower braking pressure for stopping.

The life of the steam locomotive could be maintained indefinitely by the same process as will be required to keep electric locomotives in serviceable condition, but it has been found during the past that it is more profitable to dismantle obsolete equipment and replace it by entirely new equipment than to continue the old stock in service. This will, no doubt, apply to electric locomotives when they may have reached the same average age that now results in the dismantling of steam locomotives.

From present indications, any benefit from the increased life of the electric locomotive, as compared with the steam locomotive, would be overbalanced by the cost due to continual renewals and repairs on account of ordinary wear and tear.

The cost for the first installation of power plants for generating current is too high. Under the average conditions the actual cost for the complete installation will range from $100 to $150 per horse power developed, which is from seven to ten times as much as the cost per horse power developed in the ordinary types of modern steam locomotives at a speed of 10 miles per hour.

The present types of stationary boilers are too costly and require too much floor space per horse power developed. The merits of good superheaters, economizers, feed water heaters and draft appliances should be carefully investigated for the purpose of increasing the efficiency and economy of steam boilers, which should be designed to produce more horse power per cubic foot of space occupied.

The cost for coal, ash and water supply, storage and distributing appliances as well as the expense for generators, high tension lines, transformers, exciters, converter and feeder switchboards and appliances for the distributing systems, all contribute largely to the high initial cost for power plant installations.

The size of the current generating device should not be enlarged to such an extent as will necessitate expensive foundation and building construction, overhead cranes and runways and concentrate too much power in one unit. A combination of reciprocating, turbine and internal combustion generator sets should be given consideration for the purpose of efficiency, reliability and economy.

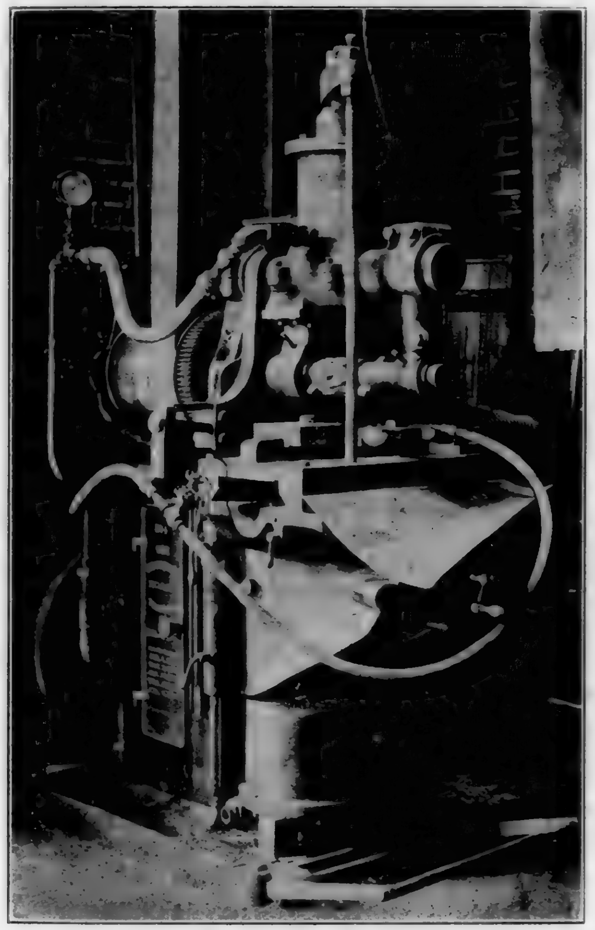
There is no doubt but that steam locomotive boilers and engines are decidedly more extravagant in fuel and water consumption than the modern power plants which are equipped with all of the refinements. At the same time there is a certain advantage and economy in the operation of a locomotive which in itself produces the power that moves it as compared with one that is dependent upon an outside source for its pro-

pulsion, and which results in transmission and conversion losses of the current before it is applied at the motors.

To electrical engineers the report and the remarks will appear to be most unfavorable for the electric locomotive operation. This, however, should not interfere with the development of an electric locomotive and power system which will give more efficient and economical results than what may have been up to the present time, or can be, obtained from steam locomotives.

What the stockholders and heads of railroads generally desire is to originate and move the greatest amount of business possible with the least cost to Capital and Operating Accounts.

The motive power engineers must co-operate in working up designs of electric locomotives. Should difficulty be experienced on account of armature burning out, the electrical engineer should not insist on the weight on driver wheels being



MACHINE FOR MILLING CAR BRASSES.

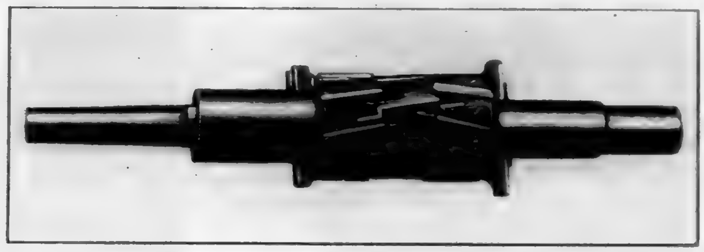
reduced to remedy the trouble; and at the same time the mechanical engineer should not require the use of pilot wheels and add unnecessary and ineffective parts and weight, if locomotives can be made to operate safely and efficiently without them.

The locomotive problem must be attacked from a transportation and motive power, and not from an electrical and mechanical engineer's viewpoint. There are sufficient locomotives of all kinds now under construction and in service on American railroads to give correct data as to what can be accomplished under varying conditions by either the electric or steam method of developing tractive power, and if unwhitewashed reports of their performance can be obtained it will be of invaluable assistance to electrical and mechanical engineers generally in meeting the present and future motive power requirements.

AUTOMOBILE EFFICIENCY TEST.—A four-cylinder air-cooled automobile carrying two passengers, ran 95 miles by using two gallons of gasolene during a test conducted by the Automobile Club of America. A gasolene-engine-propelled tricycle ran nearly 200 miles on one gallon of gasolene during the same test.

MILLING CAR BRASSES.

At the Collinwood shops of the Lake Shore & Michigan Southern Railway a No. 4 Cincinnati milling machine has been redesigned and is used entirely for the milling of car brasses. An output of four brasses per minute has been obtained from this machine and operated by an ordinary laborer, and, including the time for changing and sharpening the cutters, the machine gives an average output of 150 brasses per hour. It is entirely automatic; all that the operator has to do is to place the brass on the table, press the treadle down and release it when the brass is completed. In adapting the machine for this class of work the vertical feed screw for the table was removed and replaced by an air cylinder and piston. The height to which the table travels is regulated by means of an adjusting wedge, as shown. An automatic chuck is attached to the table, which is operated by an air cylinder; when the brass is placed on the table and the lever or treadle is operated, air is first admitted to the chuck cylinder and the brass is securely gripped. A further movement admits air below the piston of the table cylinder, raising the table and bringing the brass in contact with the milling cutter. When the table has reached the wedge the operator releases the pressure on the treadle, the table returns to its proper position, the chuck releases, and as the brass is removed a stream



INSERTED TOOTH CUTTER FOR MILLING CAR BRASSES.

of air through the hose clears the chips from the table. When large size milling cutters are used, or if the cutters are slightly dulled, the auxiliary cylinder shown above the machine is also used. It prevents excessive stresses coming on the arbor and arbor support.

The arbor of the inserted tooth cutter is made from one piece of machine steel. The tapered shank fits in the socket of the milling machine spindle. The outer end of the arbor is supported by the bracket. The carbon steel cutters are driven into milled slots. The end cutters for forming the fillet are secured by tapered keys. We are indebted for information to Mr. M. D. Franey, superintendent of the shops.

THE LARGEST STEAMERS IN THE WORLD.—A clipping, which purports to give a list of the ten largest steamers in the world, has been going the rounds of the marine press. The list is as follows:

Mauritania (Cunard), quadruple screw, turbine machinery	33,200
Lusitania (Cunard), quadruple screw, turbine machinery	33,200
Kaiserin Auguste Victoria (Hamburg-American), twin screw	25,000
Adriatic (White Star), twin screw	25,000
Baltic (White Star), twin screw	23,876
Amerika (Hamburg-American), twin screw	22,250
Cedric (White Star), twin screw	21,035
Celtic (White Star), twin screw	20,904
Caronia (Cunard), twin screw	19,594
Carmania (Cunard), triple screw, turbine machinery	19,524

This list, which we understand originated in the office of one of our American contemporaries, is incomplete in that it failed to mention the two largest ships built in the United States, which are, in cargo carrying capacity, the largest ships afloat. Their gross tonnage is greater than that of two of the Cunarders above mentioned, though less than the other ships in the list. These vessels are, of course, the *Dakota* and *Minnesota* of the Great Northern Steamship Company, and of 20,714 and 20,718 gross tons respectively. These are twin screw ships, built by the Eastern Shipbuilding Company at New London, Conn.—*International Marine Engineering.*

PERSONALS.

Mr. C. B. Cramer has resigned as master mechanic of the Southern at Sheffield, Ala.

Mr. C. I. Walker has resigned as master car builder of the National Ry. of Mexico, with office at Laredo, Tex.

Mr. W. O. Moody has been appointed Mechanical engineer of the Illinois Central R. R., with headquarters at Chicago.

Mr. A. F. Herbert, for many years general foreman of the Lake Erie & Western R. R. shops in Lima, Ohio, has resigned.

Mr. J. Stonehouse has been appointed general foreman of the Chicago & Northwestern at Huron, S. D., succeeding Mr. A. Adams, resigned.

A memorial tablet in memory of the late Edward Graftstrom, a hero of the flood at Topeka, Kan., in 1903, has been presented to the state.

Mr. R. D. Gibbons has been appointed master mechanic of the Monterey division of the Mexican Central R. R., to succeed George W. Cooper, resigned.

H. S. Lloyd has been appointed Master Mechanic of the Chattanooga Southern Ry., with office at Alton Park, Tenn., succeeding A. D. Folmer.

Mr. John T. Carroll has been appointed general foreman of the locomotive department of the Lake Shore & Michigan Southern Ry. at Elkhart, Ind.,

Mr. George Tier has been appointed foreman of the Chicago, Rock Island & Pacific Ry. at McFarland, Kan., vice Mr. R. A. Huey, assigned to other duties.

Mr. Henry J. Kutscher, who has been foreman of the Wabash shops at Springfield, Ill., for twenty-six years, has resigned, to take effect on June 1.

Mr. L. C. Rost has been appointed master mechanic of the Des Moines, Iowa Falls & Northern Ry. at Iowa Falls, Ia., vice Mr. T. D. McDonald, deceased.

Mr. S. T. Darsey has been appointed to the position of car foreman made vacant by the resignation of T. W. Sloan on the New Orleans & Northwestern Ry.

Mr. F. K. Tutt has been appointed acting master mechanic of the Missouri Pacific and Iron Mountain systems at Van Buren, Ark., vice H. K. Mudd, resigned.

Mr. W. F. Moran has been appointed master mechanic of the Southern Ry. at Sheffield, Ala., succeeding Mr. C. B. Cramer, resigned; effective on June 20.

Mr. S. E. Kildoyle has been appointed master mechanic of the Mexico division of the Mexican Central, with office at Mexico City, Mex., succeeding Mr. L. Strom, resigned.

Mr. F. Newton has been appointed master mechanic of the Sterling division, Chicago, Burlington & Quincy lines west of the Missouri river, with headquarters at Sterling, Colo.

Mr. W. H. Barrows, who has been district foreman for the Kansas City Southern Ry. at Mena, since last October, has been promoted to the position of master mechanic for the same line at Shreveport.

Mr. Michael J. Drury, master mechanic on the Albuquerque division, has been appointed master mechanic of the New Mexico and Rio Grande divisions of the Atchison, Topeka & Santa Fe Ry., with headquarters at Raton, New Mexico. He takes the place of S. W. Millinix, who resigned recently to take the position of master mechanic on the Missouri division of the Chicago, Rock Island & Pacific, with headquarters at Horton, Kans.

Mr. M. S. Tracy, assistant master mechanic of the Pennsylvania Company at Allegheny, Pa., has been transferred to Fort Wayne, Ind., in a similar capacity, succeeding Mr. L. M. Johnson, who has been transferred to Allegheny in place of Mr. Tracy.

Mr. H. M. Large, heretofore assistant master mechanic of the Erie and Ashtabula divisions of the Pennsylvania Lines, has been appointed master car builder of the Southern division of the Grand Rapids & Indiana Ry., with office at Grand Rapids, Mich.

Mr. Charles C. Newton, president and treasurer of the Newton Machine Tool Works, Inc., Philadelphia, died at Bremen, Germany, on June 13th. He was born February 9th, 1846, at Cambridge, N. Y., and at the age of nineteen he indentured himself as an apprentice to the Brooks Locomotive Works at Dunkirk, N. Y., spending most of his time in the tool room, where the foundation of his successful after career was laid. In 1880 he laid the foundation for the present Newton Machine Tool Works, Inc., at Philadelphia, in a little shop with only himself and an assistant as the working force. Mr. Newton was the sole proprietor of the works until July 14th, 1897, when articles of incorporation were taken out, not with a view of increasing the capital, but as a business move, and the firm became the Newton Machine Tool Works, Inc., with Mr. Newton as president and treasurer.

Mr. F. T. Hyndman, as announced in our last issue, has been appointed mechanical superintendent of the New York, New Haven, & Hartford R. R., succeeding F. N. Hibbits, resigned, to go to the Lehigh Valley. Mr. Hyndman was born in 1858 and began railroad service in 1872 in the Ashley shops of the Central R. R. of New Jersey. Later he was an apprentice for three years in the Wilksbarre shops of the Lehigh Valley R. R., and then was brakeman and fireman on the Central R. R. of New Jersey. In 1880 he went to the Atchison, Topeka & Santa Fe Ry. as a machinist, and the next year went to the Pittsburg & Western. From 1883 to 1895 he was engineman on the last named road, and was then appointed trainmaster. A year later he was master mechanic at Allegheny, Pa. In 1902 he went to the Baltimore & Ohio R. R., with the same title, and then to the Buffalo, Rochester & Pittsburg R. R., where he was promoted to be superintendent of motive power. In 1905 he went to the New York, New Haven, & Hartford R. R. as general master mechanic.

Single Phase Equipment for Richmond & Chesapeake Bay Railway.—The Richmond & Chesapeake Bay Railway has under construction about 15 miles of track which will be equipped immediately with single phase apparatus. Eventually this road will extend from Richmond to the Chesapeake Bay, but the portion now under construction comprises that part lying between Richmond and Ashland. The contracts for the equipment of this section have been let to the General Electric Company.

The catenary method of suspension will be used, adapted for a trolley potential of 6,600 volts. Each of the cars will be equipped with four G. E. A-603 (125) alternating current single phase motors. Multiple unit control will be furnished using the Sprague-General Electric system. The air brake system will be of the combined straight and automatic type, with C. P. A-52 motor compressors.

The Richmond & Chesapeake Bay will practically parallel the Richmond, Fredericksburg & Potomac steam road from Richmond to Ashland, and it is the intention of the trolley company to maintain a fast schedule between these two points, operating cars at very frequent intervals.

MASTER CAR BUILDERS' ASSOCIATION.

40TH ANNUAL CONVENTION.

The convention was called to order June 13, in the Sun Parlor on the Steel Pier at Atlantic City, by the president, Mr. Joseph Buker. He presented the following figures indicating the marvellous growth of the railroads during the past forty years, or since the first meeting of the Association was held: "From that little gathering in Springfield, Mass., in May, 1867, at which time there were 39,000 miles of railroad in the United States with 268 engines, 16,135 freight cars and 220 passenger cars, we have grown until, to-day, we proudly make the unchallenged claim of being the greatest association of this kind in the world, with a membership 629 in number. having jurisdiction over 2,047,327 freight cars, valued at approximately $1,037,341,800, which compose the vehicles which move 1,277,771,573 tons of freight, producing a revenue of $1,374,102,275, and 41,981 passenger cars, valued at approximately $251,886,000, handling 716,244,858 passengers, producing a revenue of approximately $456,343,380, and operating over 293,937.42 miles of railroad. This, not including cars owned by individuals or private companies; the value of such freight cars was on June 30, 1904, $72,000,000, and of cars operated by the Pullman Company $51,000,000, or a total of $123,000,000, making a grand total of $1,412,227,800 approximate valuation of passenger and freight cars."

The president called attention to the importance of being properly prepared to solve the problem of the motor car, and also those involved in the substitution of electricity for steam. The construction of cars as well as of draft gear should be carefully studied, in view of the greatly increased tractive power of present locomotives over that of those used a few years ago. That the present rules of interchange are satisfactory is evidenced by the fact that only about a dozen cases were referred to the arbitration committee during the past year. There is still a very great variety of car couplers in use which differ from each other in detail and yet all come within the requirements of the Master Car Builders' Association. The president suggested that the coupler committee should gradually change the requirements so as to finally have a single standard coupler which will fully meet all the requirements of the Interstate Commerce Commission's Safety Appliance Act. The suggestion was also made that the matter of clearances of passenger, freight and locomotive equipment, which will operate over steam roads at present being electrified, should be considered by a committee and some action be taken immediately. The members were urged to not only make a special effort to maintain a high state of efficiency in all of the safety devices now in use, but to exert themselves in inventing, constructing and testing, with a view to adopting, any new devices for improving the efficiency of safety devices and affording greater protection to both the employes and the travelling public, and to do all in their power to co-operate with and assist the Interstate Commerce Commission.

The report of the secretary showed a total membership of 631. The number of cars represented in the Association is 2,047,327. The treasurer's report showed a balance on hand of $5,104.

A resolution to the following effect, introduced by the executive committee, was adopted:

"Whereas, The Master Car Builders' Association has earnestly labored for more than a generation to bring about uniformity in car equipment, and has been aided therein by national legislation, which the Interstate Commerce Commission is directed to execute and enforce, and, in conformity with the rules of the Master Car Builders' Association, the Interstate Commerce Commission has adopted a system of inspection based on those rules, and,

"Whereas, The 77th General Assembly of the State of Ohio, in 1906, passed House Bill No. 242, which, among other things, requires the application of extra sill steps not required by national legislation, the application of which will destroy the uniformity in equipment which is so necessary for the safety of trainmen and the proper interchange of cars; therefore, be it

"Resolved, That the enforcement of such legislation will be subversive of the work of the Master Car Builders' Association, destructive of the uniformity which alone has enabled the traffic of the country to be handled from one end to the other regardless of the ownership of the cars, and, therefore, the Master Car Builders' Association earnestly protests against the enactment or enforcement of legislation by any State which is calculated to destroy the uniformity of equipment so necessary to safety and the expeditious interchange of cars."

The following amendments to the constitution were adopted: "Section 2. Any person holding the position of superintendent of the car department, master car builder, assistant master car builder, assistant mechanical superintendent, mechanical engineer, assistant mechanical engineer, assistant engineer of motive power, chief draftsman, foreman of a railroad car shop, joint car inspector, or one representative from each car manufacturing company, or other company owning or operating over one thousand cars, which are not in process of purchase by other parties, may become an active member by paying his dues for one year." Balance of section to remain as at present. Also, that Section 5, Article II., of the constitution regarding life membership, be modified so that either active or representative members who have been in good standing twenty years may become life members on the recommendation of the executive committee.

Mr. G. W. Rhodes was elected a life member of the Association, and Mr. A. H. Stucki, of Pittsburgh, was elected as an associate member.

Mr. Edward A. Moseley, secretary of the Interstate Commerce Commission, addressed the association. He deprecated the action of the Ohio State Legislature in passing a law conflicting with Master Car Builders' rules and standards. The national law is based upon the rules and standards adopted by the Association. The State has no right to control cars used in interstate commerce. Comment was also made on the improved condition of equipment as regards safety appliances, due to the action of the courts in clearly defining the safety appliance law and to the co-operation of the members of the Association with the Interstate Commerce Commission. The percentage of defective cars to the number of cars inspected was 22.59 per cent. last year as against 31.31 per cent. for the previous year.

Better arrangements should be made for handling bad order cars, and this is especially true of cars without drawbars. The law positively prohibits the hauling of cars chained together, and the commission will file information for violation of the law whenever it finds that chained-up cars have been handled in trains between terminals, and especially where it appears that such cars have been permitted to pass through repair points or terminals. The M. C. B. couplers should be of sufficient flexibility to operate on sharper curves than they do at present. The improper repairs to couplers not only increases the cost of maintenance but is unsafe. This question is of more than ordinary importance from the fact that the employer's liability law, which has just been passed by Congress, does away with the defence of contributory negligence in personal injury cases where gross negligence or disobedience of the law on the part of the employer is shown. The order of the commission increasing the minimum of air brakes in service goes into effect August 1. Roads should issue stringent orders forbiding employees to cut out air brake cars without attaching cards showing defects, and something should be done to improve the condition of retainers. That the suggestions made by Mr. Moseley met with the hearty approval of the Association was indicated by the fact that an enthusiastic rising vote of thanks was extended to him.

COMMITTEE REPORTS.

REVISION OF STANDARDS AND RECOMMENDED PRACTICE.—Mr. C. A. Schroyer (C. & N. W.) presented the report. A letter was read from Mr. O. C. Cromwell (B. & O.) suggesting that the M. C. B. standard axle be changed by substituting a ¾-in. for a ⅛-in. radius between the wheel fit and the rough collar adjoining the inside hub of the wheel, and also increasing the size of the radius between the dust guard and the wheel fit from ⅛ to ¼ in. This recommendation was referred to letter ballot. The recommendation that a committee be appointed to report at the 1907 convention on the height of couplers was adopted and referred to the executive committee. The recommendation that a special committee be appointed to investigate the matter of increasing the length of the arch bars for 80,000-lb. capacity cars was adopted. The question of changing the passenger car journal box and contained parts was referred to the executive committee. The changing of the width of the 5 x 9-in passenger car oil box from 8½ to 9 ins. was referred to letter ballot.

COMPOSITE DESIGN OF COUPLER.—Upon motion of Mr. F. H. Stark, the report of the committee was accepted and the committee discharged.

TEST OF COUPLERS.—Mr. R. L. Kleine (P. R. R.) moved that the recommendation of the committee that they be instructed in accordance with the second proposition contained in the 1905 report be approved. Carried.

CAST-IRON WHEELS.—Mr. R. L. Ettinger (So. Ry.) explained that the increase in the thickness of the flange on a line with the top of the rail was really less than 1-16 in., and that a taper of 1 in 20 had been experimented with by some roads with satisfactory results as regards flange wear. The matter of increasing the radius at the throat of the flange from 11-16 to ¾ or ⅝ in. was discussed, but the general opinion was that since this depended on the rail section, 11-16 in. was about as much as could be allowed by the American Railway Association. The report of the committee was accepted and referred to letter ballot as recommended practice.

TRIPLE VALVE TESTS.—The report was accepted and the recommendations to the effect that the testing plant at Purdue be overhauled and arranged to accommodate 100 triple valves, and that a new code of tests be formulated, were adopted.

BRAKE SHOES.—Mr. R. P. C. Sanderson (S. A. L.) suggested that the committee should give more definite information as to the nature of the material in each shoe. Dr. Goss replied that the shoes were preserved at Purdue, and that a complete analysis could be made of the various shoes, although it would be rather expensive. A motion was carried to the effect that the committee be instructed to investigate and report on a maximum coefficient of friction; also, if desirable, to recommend a change in the minimum coefficient and the coefficient at a point 15 feet from the stop. The recommendation that the testing machine be equipped for determining the wearing qualities of the shoes was referred to the executive committee for action.

BRAKE BEAMS.—This valuable report drew out a lengthy discussion, and was finally referred to the committee on standards. In introducing the report Mr. A. E. Mitchell explained that the tests were not made to determine the relative strength of the beams, but to enable the committee to prepare a proper specification. For this reason no attempt was made to test all of the beams now on the market. Mr. Nathan H. Davis, of the Davis Pressed Steel Company, suggested that the proof load should be 50 per cent. in excess of the capacity in order to eliminate all lost motion. He also advised that a distance of 9½ ins. from the centre of the pin hole to the back of the beam could not be met by their beam. Prof. H. Wade Hibbard gave a practical demonstration of the fact that the distance of the lever pin hole in front of the brake shoe is a very important dimension. If it is made too small the tendency will be for the beam to buckle sidewise. The discussion developed the fact that a beam measuring more than 9½ ins. from the centre of the pin hole to the back of the beam could not be used in a large percentage of cases, and also that certain beams could not be made with this dimension as low as 9½ ins. On the other hand a standard distance is very desirable in order that the railroads may carry a standard bottom connecting rod. Mr. W. E. Fowler suggested that the standard length of beams be made 60 ins. and that no variation be allowed from this. An amendment made by Mr. A. E. Mitchell, was carried to the effect that the recommendation requiring that the brake hangers shall be attached to the brake head at the centre just back of the central brake shoe lug be changed to allow a brake hanger to be placed 2½ ins. above the centre line for beams of I or solid section. Mr. R. F. McKenna (D., L. & W.) suggested that the minimum thickness of the metal in the jaws of the fulcrum be made ¾ in. Mr. J. J. Hennessey (C. M. & St. P.) strongly advocated the adoption of a brake beam of standard dimensions.

AXLE LIMITS.—After an extended discussion this report was adopted. While it was admitted that stenciling the car with the light and maximum weights would prove of considerable advantage from the view point of the traffic department, yet there was some question as to how it would affect the working of the rules of interchange.

INTERCHANGE RULES.—The decisions made by the arbitration committee during the year were endorsed by the convention. Very few changes were made in the rules by the arbitration committee and they were adopted without discussion.

PRICES OF REPAIRS TO STEEL CARS.—The report was adopted.

REVISION OF PASSENGER CAR RULES.—These were adopted with one or two slight changes.

REVISION OF RULES FOR LOADING LONG MATERIALS.—A spirited discussion took place on the clause limiting the height of superimposed loads to 9 ft. 3 in. The report was finally adopted after substituting the old clause for this height limit.

LOCATION OF TEMPORARY STAKE POCKETS.—Referred to letter ballot.

AIR-BRAKE HOSE SPECIFICATIONS.—The report was accepted and the committee continued. The recommendation that a committee, composed of several railroad chemists, give the matter of chemical analysis a thorough investigation was referred to the executive committee. The discussion served simply to bring out more forcibly the fact that the present physical tests, while they are useful in determining the strength of the hose are of little value as a basis of determining its durability.

HIGH-SPEED BRAKES.—The report was accepted without discussion and the committee continued for another year.

THIRD-RAIL CLEARANCES.—On the first day of the convention a committee was appointed to consider and report on this subject during the convention. The committee did not have time to draw up a written report, and Mr. F. M. Whyte presented a verbal report, reproduced on another page of this issue, outlining a report which, it was understood, would be drawn up by the committee in time for publication in the proceedings.

HEIGHT OF BRAKE STAFF.—The committee failed to submit a report, and a motion was carried that a committee of three be appointed to work in connection with a committee already appointed by the General Managers' Association to determine the height of brake staffs for box and other cars.

AUTOMATIC CONNECTORS.—The discussion of the report developed the fact that there had been a misunderstanding as to the patents on the side-port coupler. The patents covering the general principle of both the side-port and butt connectors have expired, and the existing patents cover only special features of these two types. After a spirited discussion a motion was made that the committee be instructed to continue its work and prepare standard dimensions for automatic couplings for steam-heat, air-brake and air signals, also to fix the relative location and dimensions of the different parts, so

that as cars are equipped from time to time with such automatic couplings the various makes will be interchangeable, one with another; the committee to report at the next convention. This leaves the committee free to consider either type of coupler.

Location of Side and End Ladders on Box and Stock Cars.—The recommendation in the report was amended to read that the committee on standards be instructed to modify the M. C. B. sheets and rules covering the location of grab irons to show the roof grab irons parallel to the side or end of the car on which the ladders are erected, these grab irons to be placed not less than 15 ins. from the edge of the car, and of length to suit the construction of the car. This was referred to a letter ballot.

Tank Cars.—The report was accepted and referred to letter ballot, together with the following recommendations: Mr. A. W. Gibbs (P. R. R.) suggested that each type of tank car be examined by its home road to see whether it conforms or is equal to the minimum requirements. If it does, the home road is to stencil it to show that it has been examined and passed. Mr. R. L. Kleine (P. R. R.) amended Mr. Gibbs' suggestion to the effect that the committee prepare a stencil, to be submitted to letter ballot with the report, together with specifications as to the location of the stencil on the car.

TOPICAL DISCUSSIONS.*

Circumferential Variation Allowable in Mating Wheels.—The discussion, opened by Mr. G. L. Fowler, did not bring out any statement as to the exact amount of variation allowable. It is, of course, desirable to mate the wheels as closely as possible and, while a difference in size may cause sharp flanges, it is only one of a number of other causes, and they probably often neutralize each other.

Piece-Work on Freight Car Repairs.—Mr. Le Grand Parish opened the discussion as follows: Piece-work in the car department is in such general use at the present time that little can be said which will be of interest to the Association other than calling attention to the benefits to be derived from its introduction. Much has been written about the management of piece-work and the various methods of price making, all of which is available for the use of the members, therefore, I will only mention some of the benefits which may reasonably be expected. First, and most important, is the increased car service. If we figure the earnings of freight cars, at a reasonable rate per day, the saving on this item alone will nearly pay the total labor charge, as the time on the repair tracks for heavy repairs is reduced nearly one-half. By practically doubling the capacity of the repair tracks the need for increased track facilities and congestions under day work system are relieved, and it naturally follows that the cost is reduced and earnings of the men increased, bringing about a desirable labor condition.

This system automatically betters the shop organization in general, brings about better methods of store-keeping, improving the design of equipment, calling attention to lack of proper shop and repair track facilities, and, in fact, is the only true measure of shop output. What has been said of freight car repairs is equally true of passenger car repairs. Too much cannot be said in favor of this system in the various departments of car shops. In order to bring about these conditions, however, it is necessary to have experienced piece-work supervision when the system is introduced.

Advisability of Splicing Center Sills.—This discussion was opened by Mr. F. H. Stark, and referred to cars of 50,000 lbs. or less capacity. He called attention to the fact that the rules allowed the splicing of only one center sill. Both sills are usually damaged at the same time, and nothing could be gained by splicing one sill in such a case. The discussion which followed indicated that spliced sills on all classes and capacities of cars are giving good results and coming into general favor.

The following officers were elected: President, W. E. Fowler, Canadian Pacific; vice-president G. N. Dow, L. S. & M. S.; second vice-president, R. F. McKenna, Lackawanna; third vice-president, R. W. Burnett, Erie; treasurer, John Kirby; executive committee—J. F. Walsh, F. N. Hibbits, F. T. Hyndman.

*The remaining topical discussions will be reviewed in our next issue.

FOUR-CYLINDER BALANCED SIMPLE LOCOMOTIVE.

To the Editor:

In the course of the interesting description of the Belgium State Railway, 4-6-0 type, four-cylinder balanced, single-expansion superheated steam locomotive, which appears on page 217 of the current issue of your paper, the following passage occurs: "All the cylinders are connected to the front pair of drivers, which has a built-up crank axle. The connection is such that the two cylinders on the same side of the engine are at 180 deg. with each other, and at 90 deg. with the corresponding cylinders on the opposite side. Inasmuch as all moving parts in both cylinders and the main rods are exact duplicates, it follows that this connection gives an *absolutely perfect balance* on each side of the engine. (The italics are mine.)

I beg to direct attention to the fact that this latter statement is quite incorrect, for although the above arrangement of the mechanism unquestionably reduces its dynamic disturbances to a minimum, it is nevertheless utterly impossible to obtain a *perfectly* balanced locomotive, owing to the difference in the net horizontal inertia forces of the reciprocating parts and connecting-rod at the two ends of the stroke, which inequality is produced by the combined effect of the angularity and the centrifugal force of the connecting rod.

Thus, consider the case of a locomotive of the above design, in which the reciprocating parts and connecting rods for the four cylinders are identical, and assume that the weights and dimensions of these parts coincide with those for the high-pressure cylinders of the Cole balanced Atlantic type locomotives, referred to in my paper on the "Comparative Magnitude of the Longitudinal Disturbing Forces in a Cole Balanced Compound and a Single Expansion Express Locomotive," published in the American Engineer and Railroad Journal for December, 1905, page 447.

In this article it was demonstrated that for the Cole locomotive, when at a speed in miles per hour equal to the driving wheel diameter in inches, viz.: at 80 m.p.h., or 336 r.p.m., the stresses on the high-pressure crank-pin at the dead points, due to the inertia of the reciprocating parts and the connecting rod, are 46,960.7 lb. and 42,978.5 lb., at the front and back dead centers, respectively. Consequently, even if the reciprocating parts and connecting rods of the low-pressure cylinders were exact duplicates of those for the high-pressure, there would still be an unbalanced forward inertia force of 46,960.7—42,978.5=3,982.2 lb., or nearly 2 tons, on each side of the engine at the ends of the stroke, which it is entirely impossible to neutralize.

The foregoing remarks should not be construed as an adverse criticism of the Belgium State Railway locomotive. On the contrary, I have for some time past been decidedly of opinion that this general type of engine, i.e., a four-cylinder balanced, single-expansion locomotive, with a boiler pressure not exceeding about 200 lb. per sq. in., and using highly superheated steam, will probably be the representative heavy American express locomotive of the future; the validity of which opinion is to some extent confirmed by the fact that for more than a year the motive power department of one of our most important railroad systems has considered the advisability of designing such a locomotive, and is now conducting an elaborate series of experiments that may be regarded as preliminary thereto.

The purpose of the present communication is merely to correct the prevalent erroneous impression that a locomotive of this description can be perfectly balanced in a longitudinal direction.

Edward L. Coster,
Assoc. Am. Soc. M. E.

25 Broad Street, New York,
June 12, 1906.

Lusitania.—The new Cunard Line steamer Lusitania, the world's largest liner, was successfully launched at Glasgow, Scotland, June 7. The vessel is 790 feet long, its greatest breadth is 88 feet, and its displacement is about 40,000 tons. Turbine engines will drive it at an expected speed of 24 to 25 konts.

(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE.

J. S. BONSALL,
Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT, } Editors.
E. A. AVERILL, }

JULY 1906.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

Remit by Express Money Order, Draft or Post Office Order.

Subscription for this paper will be received and copies kept for sale by the

Post Office News Co., 217 Dearborn St., Chicago, Ill.
Damrell & Upham, 283 Washington St., Boston, Mass.
Philip Roeder, 307 North Fourth St., St. Louis, Mo.
R. S. Davis & Co., 346 Fifth Ave., Pittsburgh, Pa.
Century News Co., 6 Third St., S. Minneapolis, Minn.
W. Dawson & Sons, Ltd., Cannon St., Bream's Buildings, London, E. C., England.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase of construction.*

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In many respects the Master Mechanics' and Master Car Builders' conventions held at Atlantic City have been the most successful in the history of these associations. Never have the meetings themselves been better attended. The reports and papers presented before both associations were specially good, and in several cases indicated a greater amount of research and investigation than is usually devoted to such reports. The exhibit space occupied was almost twice as large as that for the Manhattan Beach conventions. There is one thing, however, that must be criticized, and that is the noise about the "Sun Parlor" in which the meetings were held. For years, or ever since the exhibits have amounted to anything, they have been placed near the meeting room, and the noise and racket, especially at the opening meetings, has been very annoying. The same thing was true this year, and was augmented by the squeaky chairs which were provided. Railroad men, as a rule, are not trained orators, and the noise going on about them not only prevented them from being heard by members in different parts of the room, but it served to disconcert the speaker. When the importance of the work which is being done by these associations is considered, it seems a shame that better facilities are not provided for carrying on the meetings, and it is to be hoped that some action will be taken by the executive committees and the Supply Men's Association which will obviate these conditions at future conventions.

THIRD-RAIL CLEARANCES.

A committee was appointed at the first session of the Master Car Builders' Association to report during the convention on the subject of third-rail clearances. The committee did not have time to draw up a formal report, but Mr. F. M. Whyte, general mechanical engineer of the New York Central Lines, made a verbal report outlining the report which the committee would prepare in time for publication in the proceedings. Mr. Whyte's remarks are reproduced on another page of this issue. Special attention was directed to the fact that that part of the clearance diagram relating to the third rail must be considered in a different light from the remaining part of the clearance diagram. The third rail is located the same distance from the running rail on curves as on tangents, and in designing cars and locomotives it is necessary to keep far enough inside of the clearance lines to allow for curvature, and for the horizontal and vertical movements in the following tables. The offsets at the middle on a 20-deg. curve for cars of various distances between truck centers are as follows, the 20-deg. curve being referred to because the New York Central will have such curves.

Distance Between Truck Centers in Feet.	Offset in Inches.
20	2¼
22½	2¾
25	3⅜
27½	4⅛
30	4¾
32½	5⅝
35	6½
37½	7½
40	8½
42½	9½
45	10⅝
47½	11⅞
50	13⅛
52½	14½
55	15⅞
57½	17⅜
60	18⅞

The horizontal movement will amount to as much as 3½ ins. and the vertical to as much as 4⅞ ins., as shown by the following tables.

HORIZONTAL MOVEMENT.

Wear on axle collar	9/16	in.
End play on brasses	⅛	"
End wear on brasses	¼	"
Wear on wheel flanges	⅜	"
Clearance between new flanges and rail	3/16	"
Wear of rail	½	"
Construction variations	1	"
Variation in location of third rail	½	"
Total	3½	in.

VERTICAL MOVEMENT.

Wear on journals and brasses	¾	in.
*Radial wear on wheels	¼	"
Compression of springs	1⅜	"
Constructional variation	1	"
Sagging at centre of car	1	"
Variation in height of third rail	½	"
Total	4⅞	"

*This is for cast iron wheels. For steel tired wheels will be greater.

The indications are that portions of several large roads will be electrified within the next few years, and it is important that rolling equipment which is designed for general interchange shall clear these third rail installations, and in view of the foregoing it will be understood that the part of the usual clearance diagram, which provides for the third rail must be given different consideration from that given the remainder of the diagram.

MASTER MECHANICS' ASSOCIATION.

THIRTY-NINTH ANNUAL CONVENTION.

The meeting was called to order by the president, Mr. H. F. Ball. His address, which is of more than ordinary importance, is reproduced in full on another page of this issue. The rapid progress made during recent years was briefly reviewed, and the problems to be solved by the motive power department at the present time were considered. The address is one of the most valuable which has ever been presented before the Association, and is deserving of careful study by all those interested in the work of the mechanical department.

The secretary's report showed the membership as follows: Active, 777; associate, 17; honorary, 40; total, 834. The treasurer's report showed a balance on hand of $1,870.79.

A letter was read from Mr. A. J. Cassatt, president of the Pennsylvania Railroad System, thanking the Association and acknowledging the valuable assistance rendered by its representatives—Mr. F. H. Clark, Mr. C. H. Quereau, Mr. H. H. Borghan and Mr. F. M. Whyte—as members of the Advisory Committee for the locomotive tests made at the Louisiana Purchase Exposition.

The executive committee proposed several changes to the constitution. These relate to the method of electing officers and the requirements for active and honorary membership. They will be acted upon next year.

COMMITTEE REPORTS.

SHRINKAGE ALLOWANCE OF TIRES AND DESIGN OF WHEEL CENTERS.—Mr. G. W. Wildin (Erie) objected to the lip or projection on the outside of the wheel center recommended by the committee because of the difficulty in shimming a tire. Mr. G. L. Fowler suggested the advisability of increasing the carbon in the tire, making it harder, and thus overcoming the tendency toward rolling out or stretching of the tire. Several members advocated using either retaining rings or a projection as recommended by the committee as a matter of safety. Mr. H. H. Vaughan (C. P. R.) suggested that the bulk of the metal in the spoke be placed directly in line with the center of thrust on the tire. This has been done on the Canadian Pacific Railway by making the spokes of pear-shaped section, reducing the section very considerably on the outside. The wheel is easily molded, and the design is more rational than the one suggested. He also advocated making the rim of a deep U shape. This requires no more metal than the section recommended and is much stronger, thus supporting a thin tire better. Where rims are cut they should be fitted with cast-iron spacers, and not soft metal. Mr. P. Maher (I., I. & I.) advocated the use of retaining rings as a matter of safety, and described a retaining ring he is using which is put on in sections, leaving space between each section for shimming. Mr. D. J. Durrell called attention to the action of the brakes in loosening the tires.

FLEXIBLE STAYBOLTS.—Mr. Max Wickhorst (C., B. & Q.) brought out the fact that the experiments made by the committee were with clean firebox sheets and staybolts. The deflections would probably have been greater if they had been covered with scale. Mr. J. F. Walsh (C. & O.) said that they had about 15,000 flexible staybolts in about 210 engines which were giving splendid results. Two thousand five hundred of these were of the type shown on Fig. 4 of the report and the others Fig. 7 (Tate), 22 of Fig. 4 had failed in an engine after 23 months' service. Mr. A. E. Mitchell (Lehigh) said they had introduced 40,000 of the bolts shown in Fig. 7 during the past two years and had not had a single failure. Mr. D. J. Durrell (P. R. R.) said that where they had installed water purifying plants no failures of flexible staybolts had occurred in the past two years. Mr. G. W. Wildin said it was impossible to say in just what portion of the firebox the bolts were most liable to break, and advocated applying them wherever the boiler fittings would permit. Mr. D. J. Redding (P. & L. E.) said they had several locomotives equipped with the bolt shown in Fig. 7, and that it was giving good results. Mr. C. H. Doebler (Wabash) spoke of the value of the flexible staybolt for overcoming the tendency toward cracking the side sheets. The life of side sheets had been increased from 11 months to 3 years on this road, due to the use of flexible staybolts.

LOCOMOTIVE TESTS OF THE P. R. R. AT ST. LOUIS.—This report consisted of abstracts from the results of each of the tests and the summary of conclusions as given in the bound volume of results issued by the Pennsylvania Railroad Company. It was moved and carried that the report be received with thanks, the committee discharged, and that the Committee on Resolutions be instructed to prepare a memorial to the Pennsylvania Railroad showing the appreciation of the Association of the work accomplished.

WATER SOFTENING FOR LOCOMOTIVE USE.—Mr. G. R. Henderson called attention to the mention that alkali waters could not be successfully treated and stated that such waters could be distilled and thus made satisfactory for locomotive use. This would cost from 10 to 12 cents a thousand gallons. Mr. C. E. Fuller (C. & A.) gave his experience with the mechanical process mentioned in the report and stated that it was an entire success and that all engines having cylinder diameters of 19 ins. or over on the C. & A. were equipped to use this system. This had been done only after careful trial. As an example of the results attained he mentioned that flues which previously ran only 35,000 miles and firebox sheets which failed in 9 months were now being run 80,000 to 95,000 miles and from 24 to 36 months. The tonnage had been increased 27 per cent. with same engines on same division. Roundhouse work in connection with boring cylinders, facing valves, new rings, etc., had been practically eliminated. Roundhouse force takes care of the blowing off of the engines. It was further stated that this oil system required careful attention, but had given very gratifying results in every way.

Mr. D. J. Durrell stated that he had found that one purifying plant on a division would neutralize the waters of adjacent stations and show a material decrease of boiler troubles over the whole division. Roundhouse work had been reduced from 25 to 45 per cent. by the use of purified water. Other members stated that purified and treated water had resulted in very substantial reductions of boiler and roundhouse work. Mr. J. F. Walsh called attention to the results he had obtained in improved boiler conditions by the use of a hot water washing out system.

LOCOMOTIVE FRONT ENDS.—The report of this committee was given in these columns in June, page 228. It was read by Mr. H. H. Vaughan, who interposed explanations at several points, calling attention to the curious results obtained on the length of front end and to the diagrams showing the best combination of each arrangement experimented with. Mr. C. H. Quereau called attention to the fact that but 50 per cent. of the draft was utilized back of the present design of diaphragm and suggested that the matter be investigated with a view of devising a better form of diaphragm. Mr. Vaughan explained that the draft pipe was a good thing when the arrangement of the front end was not proper, but that with the correct proportions as given in the report a draft pipe would show no improvement. He said that while the tests were made without a netting, its introduction would simply mean more obstruction and require a smaller nozzle to obtain the same draft. Concerning tests on a new design of diaphragm suggested, Mr. Vaughan did not think this would be possible at Purdue. He agreed with Mr. Menzel that a draft pipe could be used to advantage in getting the proper distribution of draft, but it would lessen its amount when used with the front end suggested. Mr. F. M. Whyte stated that a number of locomotives on the New York Central had been fitted with the design of stack recommended and that it had been possible to use a larger nozzle with equally good steaming qualities. On motion of Mr. A. M. Waitt the thanks of the Association were tendered to the committee, Dr. Goss, Prof. Teague and his associates of Purdue University, for their able work in this connection.

MECHANICAL STOKERS.—The report was read and the committee continued.

CLASSIFICATION OF LOCOMOTIVE REPAIRS.—In the discussion Mr. H. A. Gillis (Amer. Loco. Co.) stated a number of cases showing that the output of a shop was not a proper gauge of the condition of the power, and said that he considered the cost of maintenance per mile or ton mile, to be a much better basis. Mr. Curtis explained the system in use on the L. & N. which is working satisfactorily. This consists of basing the output of a shop on the cost of repairs turned out. Thus, Class 1 repairs cost $100, Class 10 repairs, $1,000, etc. Mr. Quereau advocated the cost per ton mile as the proper basis for comparison. Mr. Vaughan in closing the discussion said that he did not consider the ton mile basis as of any use in locomotive repairs and advocated the 100 per cent. engine mile basis explained in the report. As a supplement to this for rough definition of a shop output he advocated the 1, 2 & 3 system of classification. It was moved and carried that 24 hours be adopted as the limit distinguishing between engines in service and those under repair and that $100, estimated labor charge, be adopted as the limit distinguishing between running and shop repairs.

ENGINE HOUSE RUNNING REPAIR WORK ON LOCOMOTIVES.—No discussion in accordance with motion carried that because of short time all reports of which committees were not present should be read by title only and discussion closed.

LOCOMOTIVE LUBRICATION.—The topical discussion of "Grease vs. Oil in Driving Box Cellars," was included in the discussion of this report. Dr. Goss read a report of some tests he had made which showed that the loss of power resulting from friction was increased by the use of grease as compared with oil. The seriousness of this loss depended largely on comparison, as it seemed to be a constant quantity of about 1,000 lbs. draw-bar pull. The sentiment seemed to be almost universal in favor of grease, which in a large number of cases was shown to largely reduce hot bearings, both pins and journals. Mr. Wildin gave some figures of the comparative cost of lubricating with grease and oil, which showed that the former cost 2.5 cents per pound per 1,000 miles and the latter 31 cents per journal per 1,000 miles. Several members had noticed a slightly increased coal consumption upon the adoption of grease, but none had had to reduce tonnage. The recommendations of the committee in regard to standard parts were referred to letter ballot and the committee continued.

THE USE OF CAST IRON IN CYLINDERS.—The committee was instructed to submit to the executive committee definite specifications with a modification in the limits for silicon. This to be submitted to letter ballot.

ELECTRICITY ON STEAM RAILROADS.—Mr. Henderson called attention to Mr. Wilgus' remarks before the New York Railroad Club to the effect that the incidental costs of arranging terminals, etc., for obtaining the full advantage of electric service was about three times the cost of equipping the track and trains. Mr. McKeen spoke of the necessity of having very heavy and strong cars for electric or motor cars in regular steam service. Mr. Street stated that the average cost of operation for all the electric lines in U. S. was 12½ cents per car mile. On one of the heaviest elevated railroads in the country the motor cars run 65,000 miles between shoppings and at that time the average cost of repairs per motor was between $2 and $3. Mr. Vaughan considered the motor car question a very live one. He thought a car should carry more than two men unless it was in strictly branch line service, where there was sure to be but one car on the line. This third man could as well be a fireman as a brakeman. The question of strength is important. He briefly described a car recently put into service on the C. P. R., which ran by steam furnished by a Scotch boiler fired with oil. It weighs 130,000 lbs. total. It was found that data and proportions relating to locomotive practice were adaptable to the steam plant on this car. The cost of operation is between 15 and 20 cents. Oil consumption is about 1.8 gal. per car mile.

INDIVIDUAL PAPERS.

VALVE GEARS FOR LOCOMOTIVES, BY C. J. MELLIN.—The discussion developed the fact that Mr. J. H. Manning (D. & H.) is conducting a test comparing three 10-wheel freight engines, one equipped with the Young valve gear, one with the Allfree-Hubbell and one with Stephenson motion and Richardson valves. Mr. D. J. Redding (P. & L. E.) said that their 19 x 26-in. passenger engines equipped with the Allfree-Hubbell gear were hauling trains formerly hauled by 20 x 26-in. simple engines.

THE MODERN LOCOMOTIVE INJECTOR.—The paper was read in abstract by its author, Mr. Strickland L. Kneass.

WELDING AND REPAIRING LOCOMOTIVE FRAMES.—On account of the absence of its author this paper was not read.

SUPERHEATED STEAM ON AMERICAN LOCOMOTIVES.—On account of the absence of its author this paper was not read.

FIRE KINDLING.—No discussion because of lack of time.

ELECTION OF OFFICERS.—The following named officers were then elected: President, J. F. Deems, New York Central; first vice-president, William McIntosh, Central of New Jersey; second vice-president, H. H. Vaughan, Canadian Pacific; third vice-president, G. W. Wildin, Erie; treasurer, Angus Sinclair, Locomotive Engineering; executive committee, F. H. Clark, C. E. Fuller, T. H. Curtis, F. M. Whyte.

(*The Topical Discussions will be reviewed in our next issue.*)

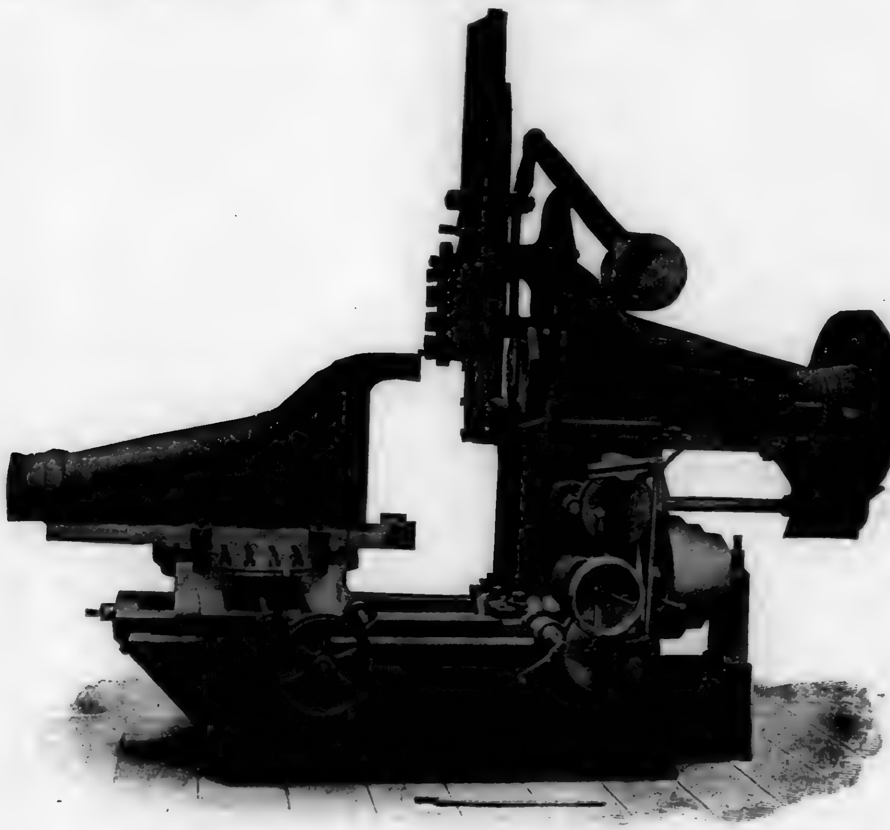
SUPERHEAT AND THE LOCOMOTIVE.—Superheating does not seem to be antagonistic to compounding, but it serves in the same general direction to reduce heat losses in the cylinders. Condensation of steam in locomotive cylinders and passages robs the locomotive of a great deal of its power, and in cold climates this becomes a serious matter. It will always be difficult to thoroughly protect the cylinders and steam passages from radiation, and therefore other precautions may be necessary to prevent the loss of heat from lessening the power of the locomotive. Superheated steam, coming into the cylinders at high temperature as it does, permits of a larger loss of heat before producing condensation than is possible with saturated steam, where the margin for loss without condensation is very small. Superheated steam may lose to the cylinders and passages a much larger proportion of its heat before condensing, and in this lies the chief advantage of its employment. Superheated steam is also quicker than saturated steam in its movements through passages and ports, as is proven by the fact that in Germany 7-in. piston valves suffice for ordinary passenger locomotives.

Such a principle as this cannot be applied to a locomotive without incurring some trouble and expense. While the improvement in the efficiency and economy of the locomotive is very readily attained, it is quite possible that it may be attained at too great an expense of restricted mileage and cost of maintenance, and it is always necessary to nurse a new development in order to make it practically successful. The possibilities of superheated steam at the present time seem to be exceedingly important, and it is perfectly safe to spend the time and money necessary for experimenting because of the practical certainty of the results.—*Mr. G. M. Basford, at Purdue University.*

INSPECTING CARS ON A PIECE-WORK BASIS.—In the car department on the New York Central every shop is now under piece-work. We are doing our inspecting at Exchange Street, Buffalo, by piece-work. I know of no other road in the country that has, as yet, attempted this. Every movement, even putting on a brake shoe, changing an air hose, and all the details, are done on a piece-work basis, and I have no doubt we will extend it throughout the system.—*F. W. Brazier, New England Railroad Club.*

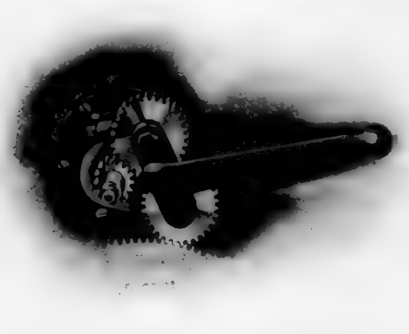
THE DILL SLOTTER.

The design of the Dill slotter differs radically from that of the ordinary type of slotting machine, as may be seen by referring to the illustrations. The manufacturer's claims for this machine are that it is able to produce a greater amount of work, that the work is more accurate and that it has a much greater range, and is not confined to the class of work usually handled by such machines. The most noticeable feature of the design is the travelling head. This head may be clamped rigidly in any position, or as the feeds operate on the head it may be fed to such work as is too cumbersome to be fed to the tool. On work not requiring an extended reach



AN AWKWARD PIECE OF WORK EASILY HANDLED ON A DILL SLOTTER.

the ram may be brought back close to the column, making it very rigid. When the cutting bar is in this positon and the table is brought forward to its limit the outside of work of very large diameters may be machined. The upward thrust is taken by the two large bolts, one on each side, which tie the bed, column and head together and are anchored in the

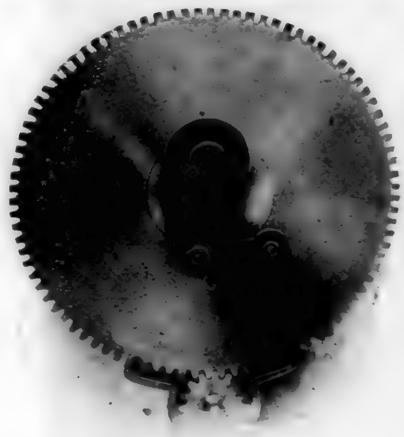


QUICK TRAVERSE GEAR.

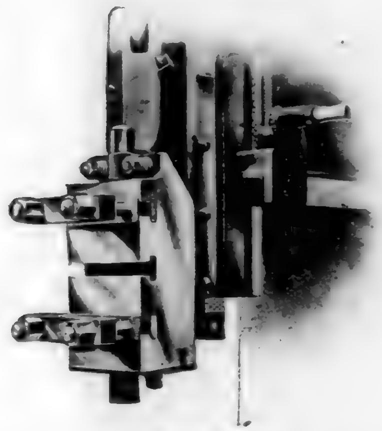
bed. Additional support is given to the frame when the ram is extended by the standard back of the column mounted on an extension of the bed, which has a sliding contact with the head when the latter is extended.

The head and compound table may be moved quickly in all directions by power by means of the quick traverse gear shown in one of the illustrations. This saves considerable time and labor in setting work to a line or to a surface already machined. This feature will also be appreciated in setting the tool in position for a second cut; this may be done while the machine proper is in motion or at rest. The gears are arranged to force themselves out of mesh if they are subjected to excessive strains, thus protecting the machine.

One of the illustrations shows the general construction of the quick return. The main driving gear moves in a path



QUICK RETURN.

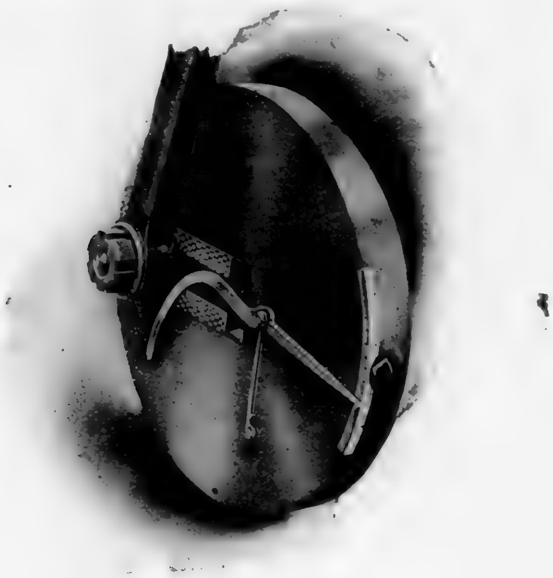


RELIEF APRON.

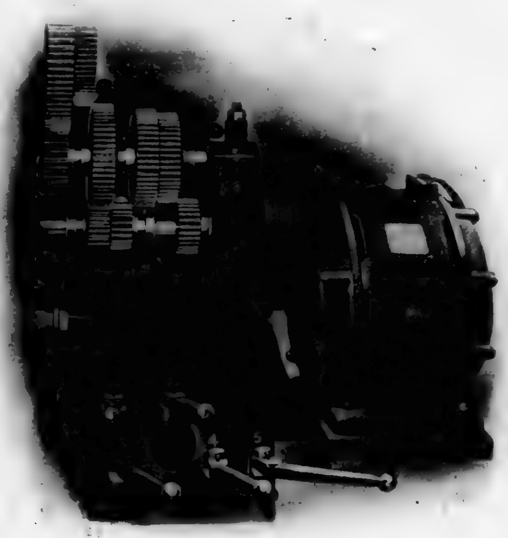
eccentric to the crank shaft, and is connected to it by a crank and a steel link instead of the usual sliding block, thus eliminating considerable friction in addition to obtaining a more uniform cutting speed. The quick part of the movement takes place at the lower end of the stroke, a point where there is but slight movement of the ram, and where there is always an excessive dwell; considerable time is thus saved, and as it takes place when the reciprocating parts are nearly at rest, it is possible to obtain a higher cutting speed than would otherwise be possible.

The feeds are operated without the use of cams, and the feed is quick and positive with a slow start. The construction is such that either intermittent or continuous feeds may be used, according to the class of work, it being possible to readily change from one to the other. The feed mechanism is protected by a safety device, so that if the head or table meets with an obstruction or undue resistance it will throw itself out of gear without injury to any part. This device is specially valuable for duplicate work, as stops may be placed to throw the feed out at any predetermined position.

The machine is equipped with a stroke indicator indicating the amount of stroke the machine is set to. This feature will be appreciated by those acquainted with the difficulties usually met in adjusting the stroke on slotters. The table is rigidly secured to the cross saddle by four corner clamps. The longitudinal saddle supports the cross saddle the full



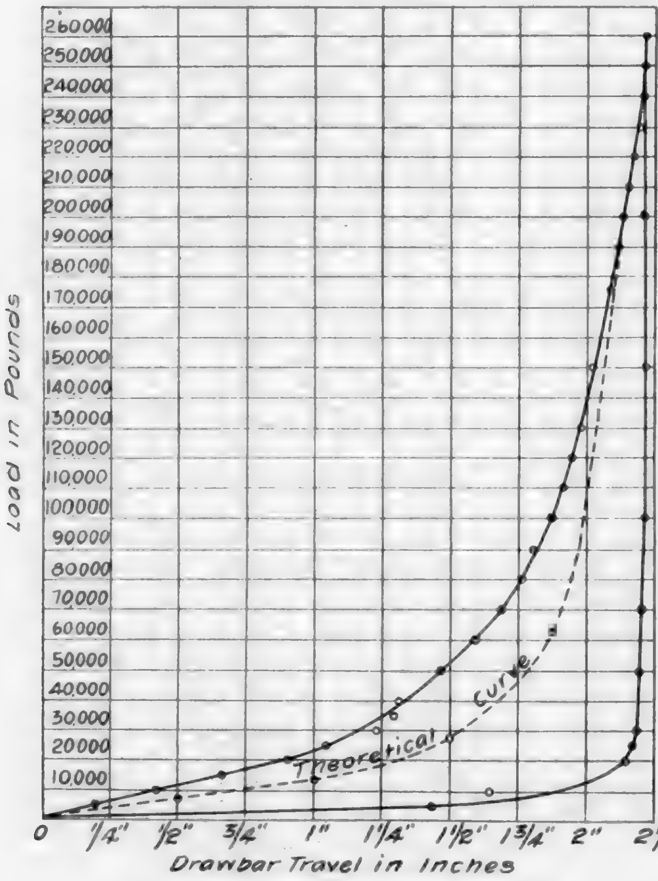
STROKE INDICATOR.



CONSTANT SPEED MOTOR DRIVE—DILL SLOTTER.

width, which is an important feature when the outer surface of the table is used much. The table is graduated in degrees, and by the aid of the quick traverse gear may be quickly and accurately set to any angle.

The ram is fitted in an adjustable guide, which may be raised or lowered by a convenient crank handle to positions where it can best support the ram. It is also provided with a relief apron hinged to the ram, well back and very low down, kept in place by two studs at the top by which it may be clamped rigidly to the ram, or permit the spring tension to be regulated to suit the work. Six changes of speed may be obtained either with a one-speed countershaft and three-step cone pulley or by a constant speed motor application, as shown in one of the illustrations. If desired, variable speed motors may readily be attached. These machines are made by the T. C. Dill Machine Company, Inc., Philadelphia, Pa.



COMPRESSION TEST—McCORD DRAFT GEAR.

McCORD DRAFT GEAR.

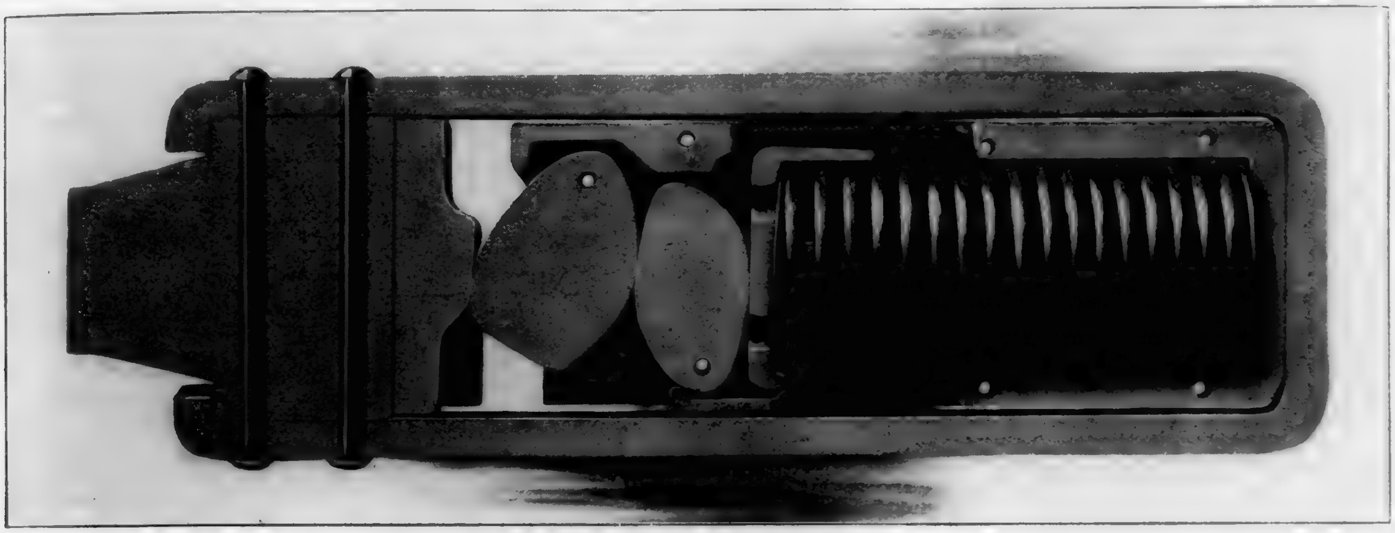
A draft gear designed on an entirely new principle has recently been perfected by McCord & Company, of Chicago, and is illustrated herewith. This gear, while it employs the use of a coil spring, cannot be classed as a spring draft gear, nor is it a friction gear, although friction unavoidably enters somewhat into its operation.

The basic idea in the design is the use of the movable fulcrum on a lever, the ends of which receive and resist the shock, i. e., the coupler acts against the end of one arm of the lever, the movement of which is resisted by a spring at the other end, and the fulcrum governing the length of the two arms of the lever changes its position with the movement, so as to increase the ratio of the lever arms in favor of the spring, as the position changes in either direction. The construction is such that the leverage against which the spring acts is twelve times as great at the end of 2⅛ ins. movement of the coupler as it was at the beginning.

McCORD DRAFT GEAR.

In order to get the device into a compact and practical form for application to cars this single lever is made in the form of two cam-shaped levers, and the variation of the leverage is secured by shaping these cams so that in rocking one upon the other the leverage is increased in practically the same way.

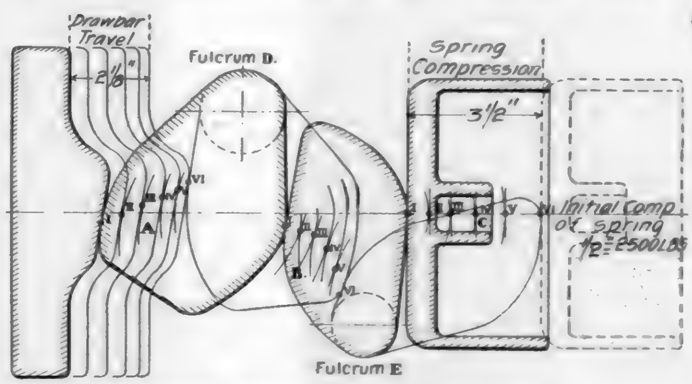
The cross-section shown herewith gives a clear idea of the location and shape of these cams and of the coil spring back



MCCORD DRAFT GEAR—SECTION SHOWING CAMS.

of them. It will be seen that the whole arrangement takes up comparatively little space, and that as assembled for use it comprises but few parts. The casing around the whole gear is formed by two malleable iron castings which have shoulders at the rear to take the place of the rear follower plate. The front follower plate of cast steel is constructed with a projection of special shape bearing against the first cam. The cams themselves are of steel and made as broad as the width of the yoke will allow. They swing upon pins which, as will be seen by a careful examination of the whole gear, carry but little stress, and hence are of light section. The spring is put into place with a ½-in. initial compression, equivalent to about 2,500 lbs., thus taking up all of the lost motion of the gear.

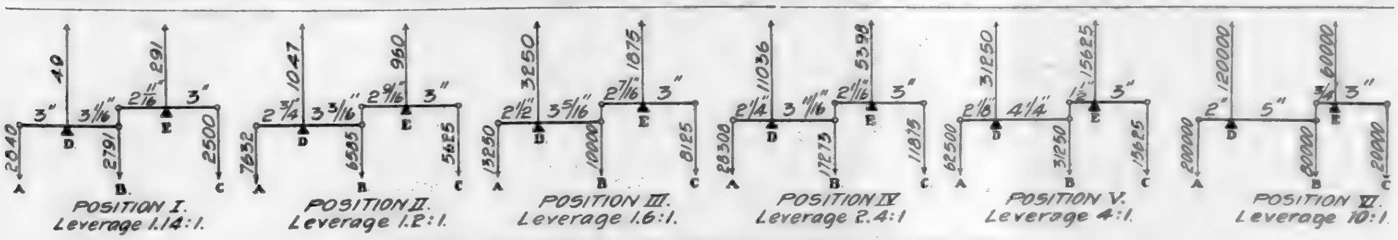
By reference to the diagram showing successive positions of the cams and the graphical illustration of the leverages, it will be seen that the resistance to the load at the start is comparatively light, and that it gradually increases in an increasing ratio as the coupler moves. This gives an elasticity to the gear until the load is increased beyond ordinary service conditions and up to the maximum draw-bar pull of present locomotives. After this point is reached the resistance increases very rapidly until the capacity of the gear is exhausted. The load applied to the front follower plate works through a leverage equal to the vertical distance between its point of contact and the fulcrum of the first cam which, it will be seen, gradually shortens as movement increases. The resultant works through a leverage equal to the vertical distance between fulcrum D and the point of contact between the two cams which, it will be seen, gradually increases with the movement. This force acts in turn upon a lever arm equal to the vertical distance between the point of contact between the two cams and the fulcrum E, which decreases with the movement in proportion as the other arm increases. This resultant force in turn acts against a lever arm equal to the distance between the point of contact of the second cam with the spring cap of 200,000 lbs., or a leverage of 10 to 1. It will be noticed, as indicated in the diagram, that the capacity of this gear is but 200,000 lbs. This, however, disregards friction, and actual tests have shown the gear to have a capacity of over 250,000 lbs. The curves given herewith show the resistance at the different points of movement both in compressing and releasing, and it will be seen that up to 1¼-in. movement of the coupler for a resistance of 30,000 lbs. the increase is very gradual, but that from beyond this point the resistance increases more and more rapidly until for the full movement of 2¼ ins. a resistance of 260,000 lbs. is indicated. The re-



MCCORD DRAFT GEAR—CAM MOVEMENT.

lease line is almost vertical down to the 30,000-lb. point, from which it returns very rapidly. A release line of a similar shape is obtained from any intermediate load.

At the final movement of the coupler head, a distance of about 2¼ ins., the spring has a movement of less than 4 ins., and at this point there is still ⅛ in. compression left in the spring, which prevents the possibility of the shock being delivered to a solid spring.



GRAPHICAL ILLUSTRATION OF LEVERAGES—MCCORD DRAFT GEAR.

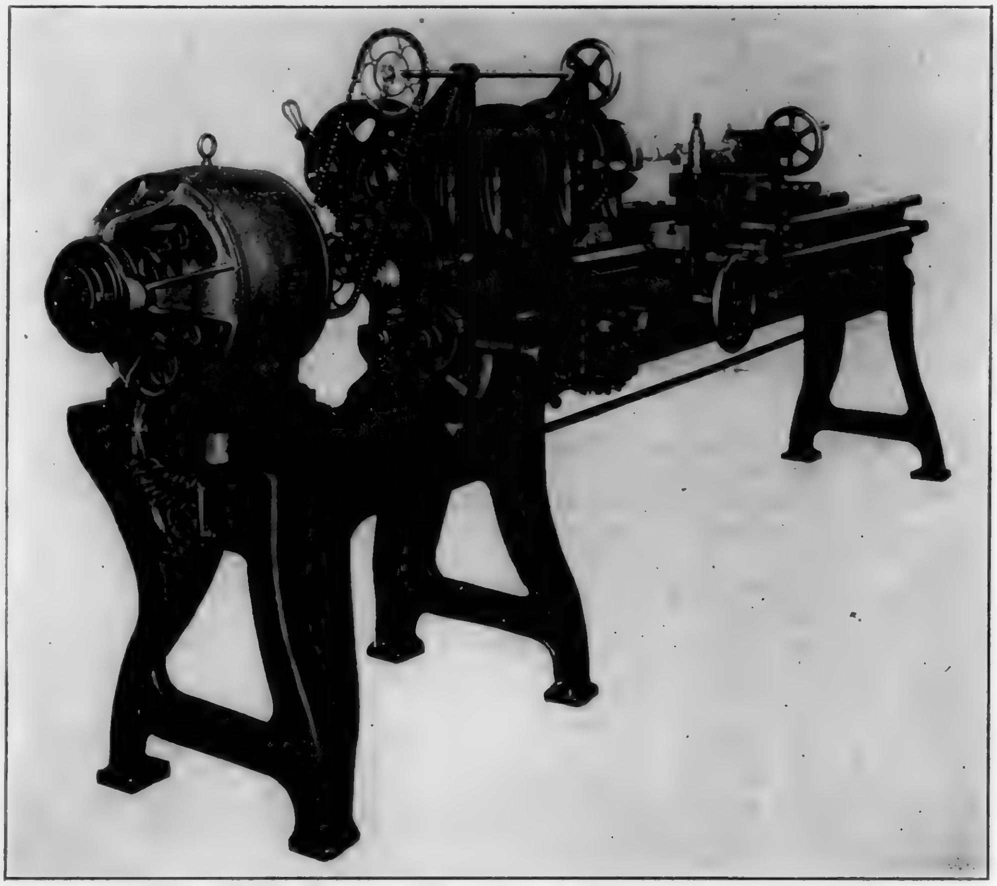
and the fulcrum E, which remains constant. This compound leverage has been worked out graphically, and is shown herewith for the different positions shown on the diagram, and it can be seen that at the start the 2,500 lbs. initial compression of the spring exerts a resistance of 2,840 lbs. against the follower plate, or a leverage of 1.14 to 1, while in the final position a resistance of 20,000 lbs. of the spring exerts a resistance

INDUSTRIAL DEPARTMENT, ERIE R. R.—During the year ending June 30, 1905, there were seventy-six new manufacturing plants located along the lines of the Erie Railroad between Chicago and New York City, outside of any medium or large size city. The industrial department of this road has shown greater activity along this line than any other with which we are familiar.

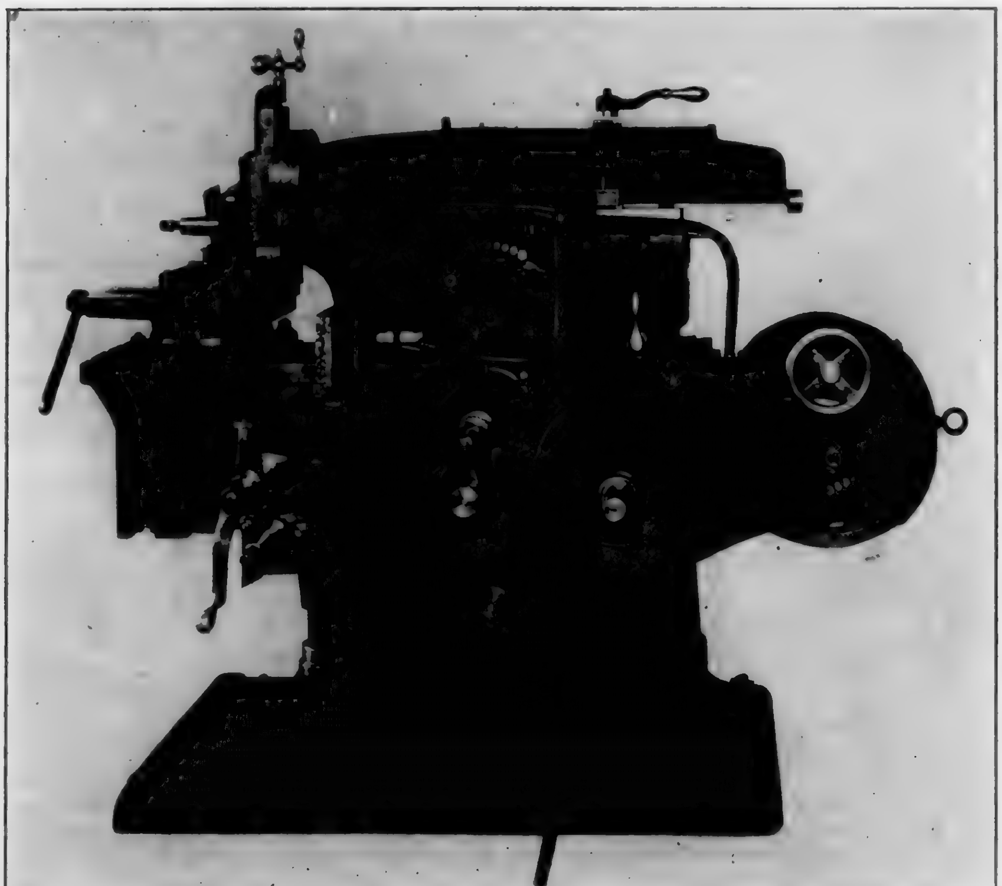
THE LINCOLN VARIABLE SPEED MOTOR.

The design and operation of the Lincoln variable speed motor differ so much from that of the ordinary type of motor that one is somewhat prepared for the rather strong claims, as to its advantages, made by the maker. The motors are regularly built for speed ranges as low as 2 to 1 and as high as 10 to 1, operating on an ordinary two-wire direct current circuit. It is claimed that the horse power is constant throughout the speed range and that the efficiency is exceptionally high. No controller is used but the changes of speed are made by withdrawing the armature from the influences of the field poles, thereby decreasing the field area and magnetic flux and increasing the air gap and resistance, thus increasing the speed. The change in speed is not made by jumps, as is the case when a controller is used, but is gradual. The motor runs equally well in either direction and is reversed in the usual way by reversing the field current. The motor is of the four pole shunt type, with the shunt field windings connected in series. The armature winding is similar to that ordinarily used in a shunt motor.

The armature is of a slightly conical shape, as shown in the drawing, thus giving a more rapid increase in the air gap and greater increase in speed for a given lateral adjustment than would be possible with a cylindrical-shaped armature. As may be seen from the illustration, the commutator end of the armature is supported by a thrust bearing carrying an annular ball bearing enclosed and protected from dirt to take both the thrust and the radial loads. This thrust bearing is actuated by a split lever having a central pull on the opposite sides of the thrust bearing, the movement of the lever being accomplished by means of a screw mechanism and hand wheel, a spring around the lever connecting rod being adjusted to balance the magnetic pull on the armature. The full range of speed may be obtained with a few revolutions of the hand wheel.



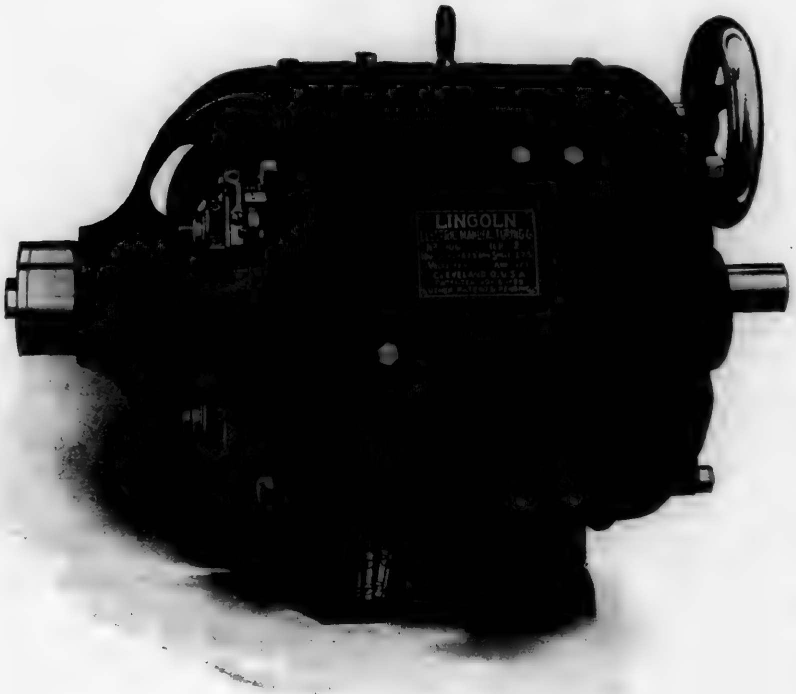
APPLICATION OF LINCOLN VARIABLE SPEED MOTOR TO LODGE & SHIPLEY LATHE.



APPLICATION OF LINCOLN MOTOR TO QUEEN CITY SHAPER.

It is claimed that the motor may be overloaded as much as 100 per cent. at any speed without sparking, and that at lower speeds an even greater overload may be carried for short periods. It is stated that the efficiency at full load of a 5-h.p., 5 to 1 motor is from 86 per cent. at 300 r.p.m. to 75 per cent. at 1,500 r.p.m. It is also claimed that the motor speed is not affected by varying the load conditions.

One of the illustrations shows an application of the motor to one of the latest designs of



LINCOLN VARIABLE SPEED MOTOR.

shaper made by the Queen City Machine Tool Company, Cincinati, Ohio. The shaper has an improved feeding mechanism, the adjustment of which is made at the cross-rail. The drive is through a Morse chain protected by a casing as shown. The motor feet rest on pads on the side of the column, making the installation very compact. Another illustration shows an application to a Lodge & Shipley 16-in. lathe, the motor being supported by an extension of the frame which supports one end of the lathe bed. The hand wheel which controls the motor speed is placed above the head stock, convenient to the operator in his working position, and is connected to the motor by a shaft and link chain as shown. The motors on these two machines are both of an old experimental type, but correspond in size to the present 3½-h.p., 350 to 1,750 r.p.m. motor. As may be seen, the motor is quite small considering its capacity. The design of this motor has been patented by Mr. John C. Lincoln, and it is being manufactured by the Lincoln Manufacturing Company, Cleveland, Ohio.

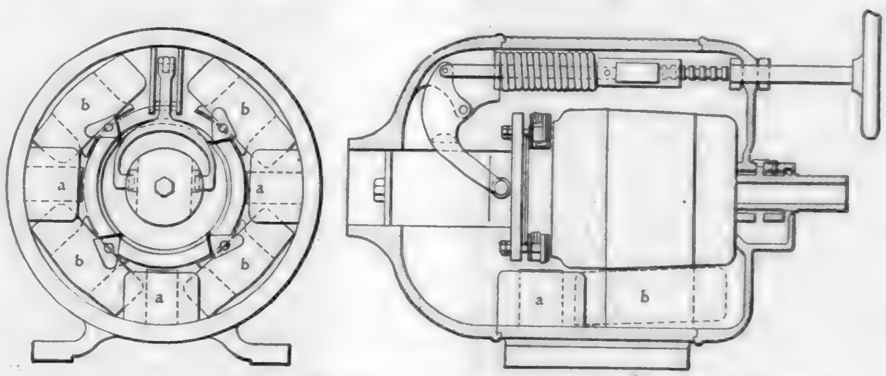
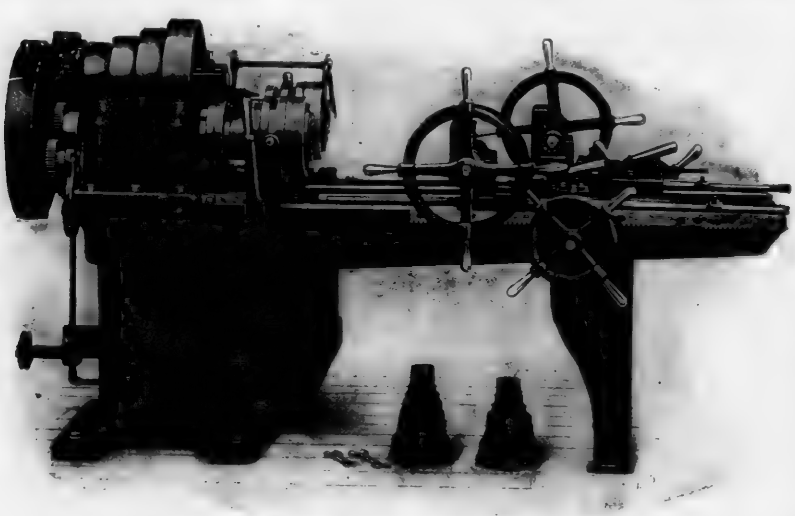


DIAGRAM SHOWING CONSTRUCTION OF LINCOLN MOTOR.



RELIANCE 1½-IN. DOUBLE STAYBOLT CUTTER.

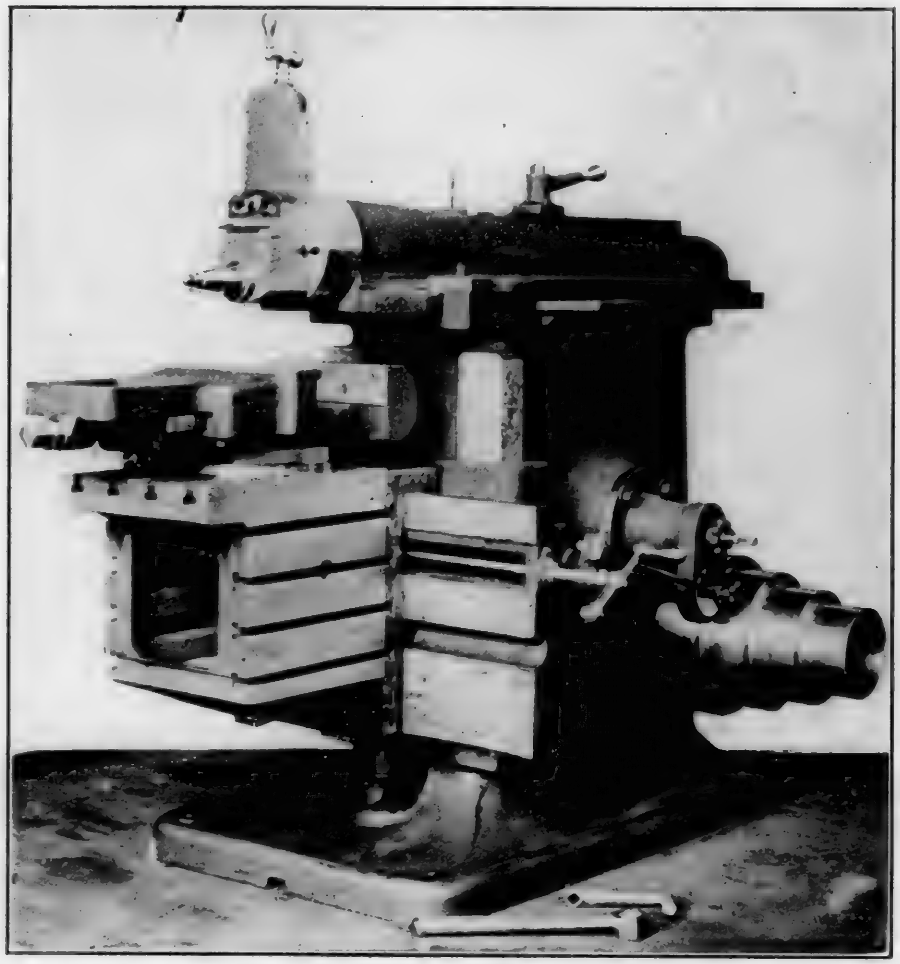
1 1-2 INCH DOUBLE STAYBOLT CUTTER.

The Reliance 1½-in. double staybolt cutter, shown in the illustration, is also built single, in 1½ and 2-in. sizes. The lead screw is located directly underneath the head stock and carriage, and is driven from the spindle by gearing. It is of large size with a coarse thread to insure long life. An automatic safety device disconnects the nut from the lead screw at the end of the forward travel of the carriage and thus prevents injury to the machine, if through carelessness of the operator the carriage should be forced against the die head.

The die head holds the dies rigidly in the working position and the locking mechanism releases freely. The locking mechanism consists of a positive hardened and ground lock bolt which snaps into a hardened and ground bushing when the barrel reaches the proper position. To further increase the efficiency of the dies the chasers fit into the die holders, thus preventing them from bearing on the die head. The holders, of tool steel hardened and ground, are of large proportions, thus preventing any tendency to clamp or bind, giving a large wearing surface and increasing the rigidity of the die head. The chasers are quickly and carefully adjusted by means of a screw. These machines, furnished for either belt or motor drive, are built in standard sizes from ¾ to 6 ins., inclusive. They are made by Foote, Burt & Company, Cleveland.

25 INCH HEAVY DUTY CRANK SHAPER.

The 25-in. heavy duty, back-geared crank shaper, illustrated herewith, is noteworthy because of the ease of manipulation, its great power and large capacity, and its simple and substantial construction. The column, of large proportions, is internally ribbed throughout, contains bored seats for all journal boxes, a flange for the crank gear sleeve, has a long bearing surface for the ram, and the ways for the cross rail extend from the top to the bottom of the column, thus making it very rigid. The base extends well out in the front, and is pan-shaped with no corners to prevent the oil and chips from being easily removed. The ram is long and wide, and is internally ribbed in such a way that it is strongest at that point which is subjected to the most severe strains. All adjustments may easily be made while the ram is in motion. It is 12 ins. wide, has a bearing in the column 37 ins. in length, and has a maximum stroke of 26½ ins. The tool head may be swiveled to any angle, and is securely locked by two bolts. The down-feed screw is provided with a micrometer collar reading to .001 in., and, if desired, may be fur-



SPRINGFIELD 25-IN. HEAVY DUTY CRANK SHAPER.

nished with an automatic down and angular feed.

The cross rail has a very long bearing on the column and is self-aligning, one of the ways on the column having an angular back face which the gib fits. By first tightening the screws in this gib, after an adjustment, the rail will always be square. The telescopic elevating screw is equipped with ball bearings. The table has large working surfaces on three sides. Instead of bolting it to the cross slide by means of planer bolts in the T slots, it has three large studs passing entirely through the top of the cross slide above the bearing on the cross rail. The cast iron is thus relieved of tensile strains and is placed under compression, which it is much better adapted to withstand. There are also two bolts at the bottom. No support is required under the box table, because of the enlargement of the ways on the column, the deeper cross rail, the method of fastening the table to the cross rail and the rigid design of the table. The table has a vertical adjustment of 15 ins. and a cross motion of 32 ins. The top surface of the table is 15¼ by 20 ins., and the depth of the cross rail is 21 ins.

The jaws of the vise are faced with steel, open 15 ins., and are 15 ins. wide and 3 ins. deep. The screw is entirely protected from chips and dirt. The crank gear journal has two diameters, thus reinforcing it at the point of greatest strain. It has large seats for the wrist block, heavily gibbed with provision for adjustment. The stroke arm is connected to the ram by means of a link in such a way as to provide space to allow a 4-in. shaft to pass entirely through the column for keyseating. The gears of the driving mechanism have wide faces and large pitches. The cone is designed for a 4-in. belt, is of large diameter and has four speeds, which, in connection with the back gears, gives eight speeds to the machine. The shafts are provided with a ring oiling device.

The net weight of this machine, which is made by the Springfield Machine Tool Company, of Springfield, Ohio, is 4,600 lbs.

UNIQUE OPERATION PERFORMED BY LOCOMOTIVE CRANE.

The illustration shows a unique operation recently performed by a No. 2 Browning locomotive crane. A 100-ft. steel smokestack was erected for a power station, the crane working at a radius of 25 ft. The top section of the stack weighed 4½ tons, and the photograph was taken as it was being lifted into place. It was necessary for the occasion to tie the heavy 40-ft. timber to the 65-ft. boom, leaving 10 ft. for lap.

The crane which was made by the Browning Engineering Company of Cleveland, Ohio, is operated by steam, and is designed for service on a standard gauge track. It has a tractive effort equal to that of an ordinary yard locomotive. These cranes are equipped either with or without a grab bucket or a hook block, and may be used for such work as handling coal or ashes, light wrecking, switching cars, heavy hauling and hoisting material of various kinds.

Ferris Wheel Destroyed.—The Ferris Wheel which was constructed especially for the Midway at the Columbian Exposition, and was removed to St. Louis for the Louisiana Exposition, was destroyed by dynamite on May 11.

BROWNING LOCOMOTIVE CRANE IN OPERATION.

MASTER CAR BUILDERS' ASSOCIATION.

ABSTRACTS OF REPORTS.

BRAKE BEAMS.

Committee—A. E. Mitchell, chairman; R. B. Kendig, W. E. Sharp, W. F. M. Goss, G. W. Wildin.

Recognizing that the present standard requirements (adopted in 1889) for freight brake beams are inadequate for existing conditions of service, and that a very large percentage of the brake beams now used do not even approximate the M. C. B. specifications, this Association last year appointed your committee to investigate the subject and submit specifications and tests for brake beams for 60,000-lb., 80,000-lb. and 100,000-lb. capacity cars. Your committee found it necessary—

First—To determine the strength of the beams now on the market and ascertain their adaptability to the service required, which necessitated an investigation and test of the various beams which are now generally used. This investigation was undertaken for your committee by Purdue University as represented by Dean Goss, and was directed by Dr. W. K. Hatt, Professor of Applied Mechanics. Dr. Hatt was assisted by H. H. Scofield, Instructor of Applied Mechanics. [The brake beams were submitted to both the direct or pulling test and to a transverse test, and the results of these tests, as well as a description of the testing machine, are fully considered in appendices accompanying the report.]

Second—The duty of determining the proper location and dimensions of brake beams, to enable the committee to prepare specifications for beams of proper strengths, was delegated to a sub-committee, composed of Mr. R. B. Kendig, mechanical engineer of the L. S. & M. S. Railway, and a member of our committee; Mr. J. G. Platt, engineer of tests, Erie Railroad, and Mr. L. L. Bentley and his successor, Mr. J. N. Mowery, mechanical engineer, Lehigh Valley Railroad Company.

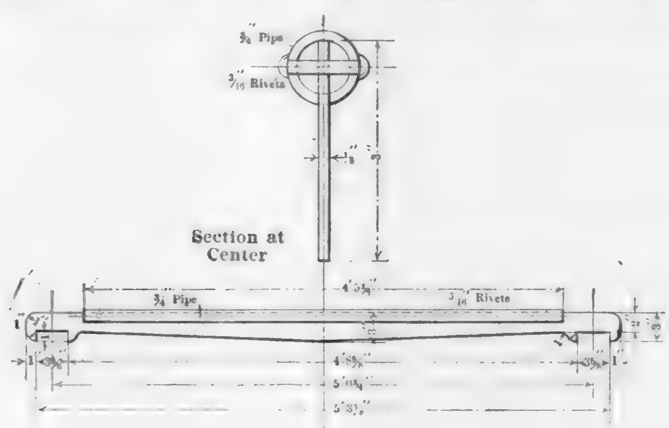


FIG. 3.—BRAKE BEAM GAUGE.

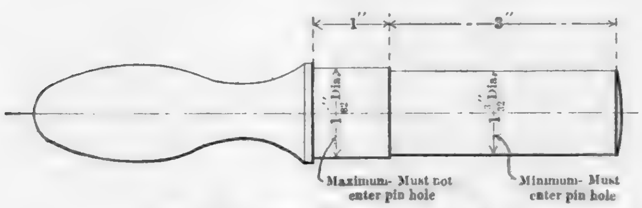


FIG. 6.—LEVER PIN HOLE GAUGE.

In order to carry out the tests at Purdue University, several beams of the various makes were taken from regular stock and donated to the committee by the following companies: Pennsylvania Railroad, Erie Railroad, L. S. & M. S. Railway, Lehigh Valley Railroad, Armour Car Lines, Pressed Steel Car Company, Buffalo Brake Beam Company, Chicago Railway Equipment Company, Gilbert P. Ritter.

PRESENT CONDITIONS.—A general review of the brake beam situation disclosed a deplorable state of affairs. It may seem a startling statement, but it is nevertheless true, that in many directions less attention is now being given to brake beams (the vital part of the foundation brake rigging) than twelve or fourteen years ago, notwithstanding markedly changed conditions, as well as greatly increased requirements of service. It also appears that in some cases *any* "metal brake beam" is interpreted as an acceptable beam.

INEFFICIENT BRAKE BEAMS.—Notwithstanding the increased requirements of to-day, due to both the weight of cars and speed of trains, and the fact that the present M. C. B. standard beams are not sufficiently strong for the service, a very large number of brake beams now being used do not even meet the specifications of 1889. The result is that such brake beams not only give inefficient service but soon fail.

Investigation shows that many new freight cars have been equipped with brake beams hung at variance with the M. C. B. standard height, also at variance with the height for which the brake beams were designed. This misapplication produces a torsional strain on the beams when the power is applied. This abuse, taken in connection with the overloading of weak brake beams, has resulted in a continually increasing number of distorted and broken beams, and has misled some to make the erroneous deduction that there is a "vertical" stress or load produced in service, which should be provided for.

Many roads are still applying "outside hung" brake beams, which we believe is radically wrong, as it is impossible to obtain satisfactory results with beams so hung. Outside hung beams are affected by the action of the bolster springs, curving of the trucks, sagging of the car body, etc., all of which prevent effective braking, and particularly under the varying conditions of loaded and empty cars. There is no argument in favor of such an arrangement, with the one exception, that they are more accessible.

A brake beam should be hung inside of the wheels to some *rigid* portion of the truck, so that it will always maintain the same relative position to the wheels; when so hung the beams are easier to maintain, and, not being exposed, are less liable to be struck by obstructions on the track (impromptu bumping posts, etc.). The first cost of the inside hung brake beam is less, they cost less to apply, and, most important of all, give more effective results in braking.

SUMMARY.

Your committee accordingly recommends for adoption as standard, two brake beams, which shall be known as beam No. 1, for use under cars having a light weight of 30,000 lbs. or less, and beam No. 2, which shall be used under cars having a light weight in excess of 30,000 lbs. Both beams shall conform to the following specifications:

SPECIFICATIONS.

1. All beams shall be 60¼ ins. in length from center to center of brake head, with an allowable variation of ¼ in. in each direction, and shall be proven by the gauge shown by Fig. 3, applied

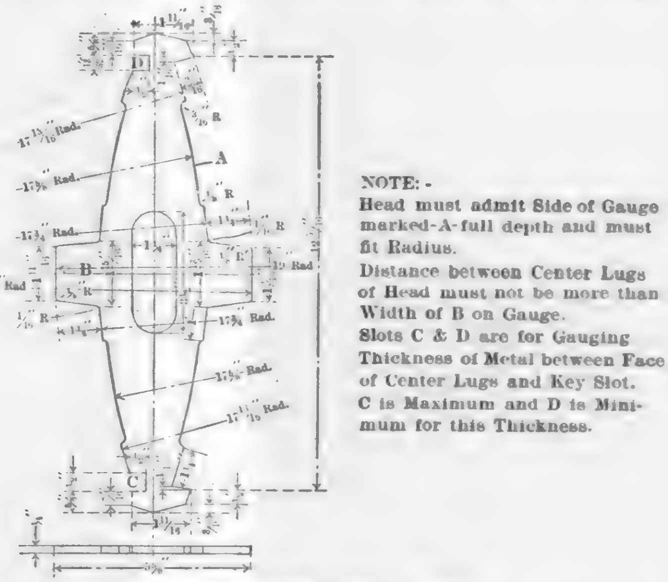


FIG. 5.—BRAKE HEAD GAUGE.

to the center and each end of the brake heads, which shall be the standard gauge for this purpose.

2. All brake heads shall conform to the M. C. B. standard dimensions, and shall be proven by the gauge shown by Fig. 5, which shall be the standard gauge for this purpose.

3. Attachments for safety hangers shall be 51 ins. from center to center.

4. The angle of the lever fulcrum shall be 40 deg. from the vertical.

5. The lever pinhole shall be 3 ins. in front of the top of the brake head lugs. The variation in either direction shall not exceed 1-16 in.

6. The lever pinhole shall not be less than 1 3-32 ins. in diameter, nor more than 1 5-32 in diameter, and shall be proven by the gauge shown by Fig. 6, which shall be the standard gauge for this purpose.

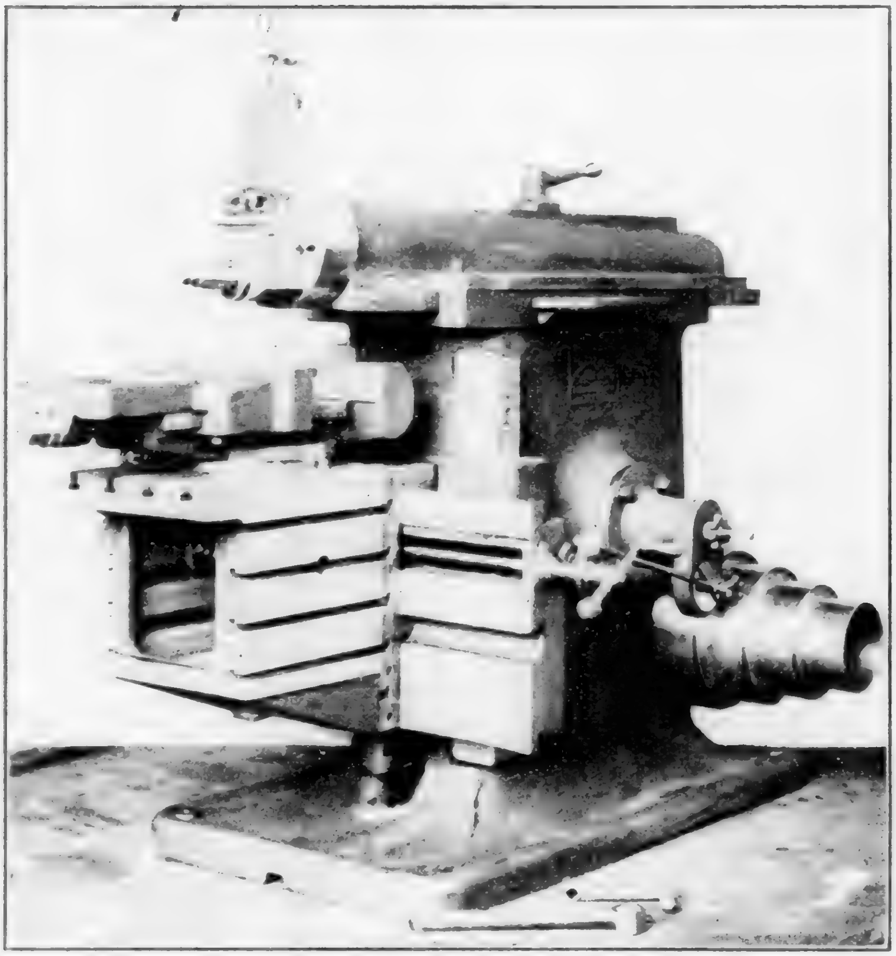
7. The maximum distance from the lever pinhole to the extreme back of brake beam should not exceed 9½ ins.

TEST.

8. For each 500 brake beams, or less, which pass inspection and are ready for shipment, one representative beam shall be taken at random, and subjected by the company manufacturing the beams, and in the presence of the railroad company's inspector, to the following test in a suitable machine:

The beams shall be equipped with suitable heads and shoes, and the shoes placed in contact with castings representing the tread of the wheel; when mounted in this manner the load shall be applied to the fulcrum in the normal line of pull. As a preliminary to the test, a load equal to the rated capacity shall be applied and released, after which observations for records shall be taken. Beam No. 1, under a load of 7,500 lbs., shall not deflect to exceed .0625 in.; beam No. 2, under a load of 15,000 lbs., shall not deflect to exceed .0625 in.

9. In case a beam shall fail in this test then a second beam shall be taken from the same lot and similarly tested. If the second beam stands the test, it shall be optional with the inspector whether he shall test a third beam or not. If he does not do so,



SPRINGFIELD 25-IN. HEAVY DUTY CRANK SHAPER.

UNIQUE OPERATION PERFORMED BY LOCOMOTIVE CRANE.

The illustration shows a unique operation recently performed by a No. 2 Browning locomotive crane. A 100-ft. steel smokestack was erected for a power station, the crane working at a radius of 25 ft. The top section of the stack weighed $4\frac{1}{2}$ tons, and the photograph was taken as it was being lifted into place. It was necessary for the occasion to tie the heavy 40-ft. timber to the 65-ft. boom, leaving 10 ft. for lap.

The crane which was made by the Browning Engineering Company of Cleveland, Ohio, is operated by steam, and is designed for service on a standard gauge track. It has a tractive effort equal to that of an ordinary yard locomotive. These cranes are equipped either with or without a grab bucket or a hook block, and may be used for such work as handling coal or ashes, light wrecking, switching cars, heavy hauling and hoisting material of various kinds.

FERRIS WHEEL DESTROYED.—The Ferris Wheel which was constructed especially for the Midway at the Columbian Exposition, and was removed to St. Louis for the Louisiana Exposition, was destroyed by dynamite on May 11.

nished with an automatic down and angular feed.

The cross rail has a very long bearing on the column and is self-aligning, one of the ways on the column having an angular back face which the gib fits. By first tightening the screws in this gib, after an adjustment, the rail will always be square. The telescopic elevating screw is equipped with ball bearings. The table has large working surfaces on three sides. Instead of bolting it to the cross slide by means of planer bolts in the T slots, it has three large studs passing entirely through the top of the cross slide above the bearing on the cross rail. The cast iron is thus relieved of tensile strains and is placed under compression, which it is much better adapted to withstand. There are also two bolts at the bottom. No support is required under the box table, because of the enlargement of the ways on the column, the deeper cross rail, the method of fastening the table to the cross rail and the rigid design of the table. The table has a vertical adjustment of 15 ins. and a cross motion of 32 ins. The top surface of the table is $15\frac{1}{4}$ by 20 ins., and the depth of the cross rail is 21 ins.

The jaws of the vise are faced with steel, open 15 ins., and are 15 ins. wide and 3 ins. deep. The screw is entirely protected from chips and dirt. The crank gear journal has two diameters, thus reinforcing it at the point of greatest strain. It has large seats for the wrist block, heavily gibbed with provision for adjustment. The stroke arm is connected to the ram by means of a link in such a way as to provide space to allow a 4-in. shaft to pass entirely through the column for keyseating. The gears of the driving mechanism have wide faces and large pitches. The cone is designed for a 4-in. belt, is of large diameter and has four speeds, which, in connection with the back gears, gives eight speeds to the machine. The shafts are provided with a ring oiling device.

The net weight of this machine, which is made by the Springfield Machine Tool Company, of Springfield, Ohio, is 4,600 lbs.

BROWNING LOCOMOTIVE CRANE IN OPERATION.

MASTER CAR BUILDERS' ASSOCIATION.

ABSTRACTS OF REPORTS.

BRAKE BEAMS.

Committee—A. E. Mitchell, chairman; R. B. Kendig, W. E. Sharp, W. F. M. Goss, G. W. Wildin.

Recognizing that the present standard requirements (adopted in 1889) for freight brake beams are inadequate for existing conditions of service, and that a very large percentage of the brake beams now used do not even approximate the M. C. B. specifications, this Association last year appointed your committee to investigate the subject and submit specifications and tests for brake beams for 60,000-lb., 80,000-lb. and 100,000-lb. capacity cars. Your committee found it necessary—

First—To determine the strength of the beams now on the market and ascertain their adaptability to the service required, which necessitated an investigation and test of the various beams which are now generally used. This investigation was undertaken for your committee by Purdue University as represented by Dean Goss, and was directed by Dr. W. K. Hatt, Professor of Applied Mechanics. Dr. Hatt was assisted by H. H. Scofield, Instructor of Applied Mechanics. [The brake beams were submitted to both the direct or pulling test and to a transverse test, and the results of these tests, as well as a description of the testing machine, are fully considered in appendices accompanying the report.]

Second—The duty of determining the proper location and dimensions of brake beams, to enable the committee to prepare specifications for beams of proper strengths, was delegated to a sub-committee, composed of Mr. R. B. Kendig, mechanical engineer of the L. S. & M. S. Railway, and a member of our committee; Mr. J. G. Platt, engineer of tests, Erie Railroad, and Mr. L. L. Bentley and his successor, Mr. J. N. Mowery, mechanical engineer, Lehigh Valley Railroad Company.

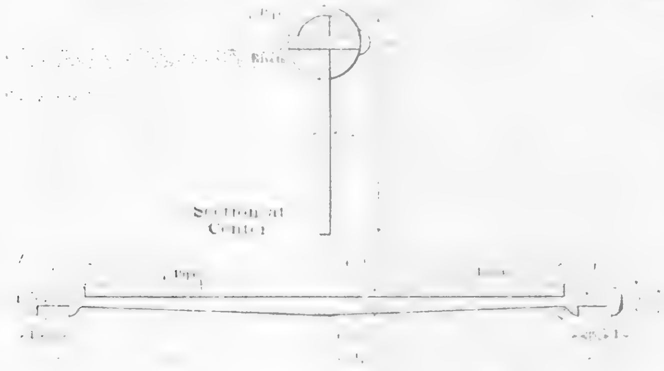


FIG. 3.—BRAKE BEAM GAUGE.

FIG. 6.—LEVER PIN HOLE GAUGE.

In order to carry out the tests at Purdue University, several beams of the various makes were taken from regular stock and donated to the committee by the following companies: Pennsylvania Railroad, Erie Railroad, L. S. & M. S. Railway, Lehigh Valley Railroad, Armour Car Lines, Pressed Steel Car Company, Buffalo Brake Beam Company, Chicago Railway Equipment Company, Gilbert P. Ritter.

PRESENT CONDITIONS.—A general review of the brake beam situation disclosed a deplorable state of affairs. It may seem a startling statement, but it is nevertheless true, that in many directions less attention is now being given to brake beams (the vital part of the foundation brake rigging) than twelve or fourteen years ago, notwithstanding markedly changed conditions, as well as greatly increased requirements of service. It also appears that in some cases *any* "metal brake beam" is interpreted as an acceptable beam.

INEFFICIENT BRAKE BEAMS.—Notwithstanding the increased requirements of to-day, due to both the weight of cars and speed of trains, and the fact that the present M. C. B. standard beams are not sufficiently strong for the service, a very large number of brake beams now being used do not even meet the specifications of 1889. The result is that such brake beams not only give inefficient service but soon fail.

Investigation shows that many new freight cars have been equipped with brake beams hung at variance with the M. C. B. standard height, also at variance with the height for which the brake beams were designed. This misapplication produces a torsional strain on the beams when the power is applied. This abuse, taken in connection with the overloading of weak brake beams, has resulted in a continually increasing number of distorted and broken beams, and has misled some to make the erroneous deduction that there is a "vertical" stress or load produced in service, which should be provided for.

Many roads are still applying "outside hung" brake beams, which we believe is radically wrong, as it is impossible to obtain satisfactory results with beams so hung. Outside hung beams are affected by the action of the bolster springs, curving of the trucks, sagging of the car body, etc., all of which prevent effective braking, and particularly under the varying conditions of loaded and empty cars. There is no argument in favor of such an arrangement, with the one exception, that they are more accessible.

A brake beam should be hung inside of the wheels to some *rigid* portion of the truck, so that it will always maintain the same relative position to the wheels; when so hung the beams are easier to maintain, and, not being exposed, are less liable to be struck by obstructions on the track (impromptu bumping posts, etc.). The first cost of the inside hung brake beam is less, they cost less to apply, and, most important of all, give more effective results in braking.

SUMMARY.

Your committee accordingly recommends for adoption as standard, two brake beams, which shall be known as beam No. 1, for use under cars having a light weight of 30,000 lbs. or less, and beam No. 2, which shall be used under cars having a light weight in excess of 30,000 lbs. Both beams shall conform to the following specifications:

SPECIFICATIONS.

1. All beams shall be $60\frac{1}{4}$ ins. in length from center to center of brake head, with an allowable variation of $\frac{1}{8}$ in. in each direction, and shall be proven by the gauge shown by Fig. 3, applied to the center and each end of the brake heads, which shall be the standard gauge for this purpose.

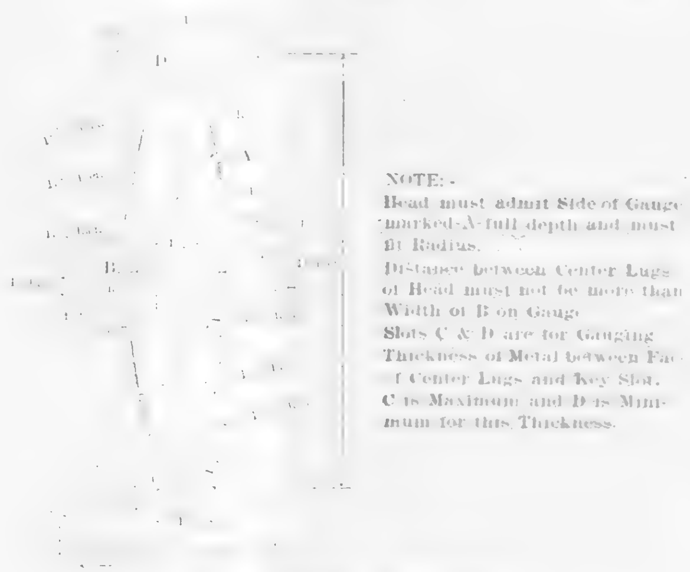


FIG. 5.—BRAKE HEAD GAUGE.

2. All brake heads shall conform to the M. C. B. standard dimensions, and shall be proven by the gauge shown by Fig. 5, which shall be the standard gauge for this purpose.

3. Attachments for safety hangers shall be 51 ins. from center to center.

4. The angle of the lever fulcrum shall be 40 deg. from the vertical.

5. The lever pinhole shall be 3 ins. in front of the top of the brake head lugs. The variation in either direction shall not exceed 1-16 in.

6. The lever pinhole shall not be less than 1 3-32 ins. in diameter, nor more than 1 5-32 in diameter; and shall be proven by the gauge shown by Fig. 6, which shall be the standard gauge for this purpose.

7. The maximum distance from the lever pinhole to the extreme back of brake beam should not exceed $9\frac{1}{2}$ ins.

TEST.

8. For each 500 brake beams, or less, which pass inspection and are ready for shipment, one representative beam shall be taken at random, and subjected by the company manufacturing the beams, and in the presence of the railroad company's inspector, to the following test in a suitable machine:

The beams shall be equipped with suitable heads and shoes, and the shoes placed in contact with castings representing the tread of the wheel; when mounted in this manner the load shall be applied to the fulcrum in the normal line of pull. As a preliminary to the test, a load equal to the rated capacity shall be applied and released, after which observations for records shall be taken. Beam No. 1, under a load of 7,500 lbs., shall not deflect to exceed .0625 in.; beam No. 2, under a load of 15,000 lbs., shall not deflect to exceed .0625 in.

9. In case a beam shall fail in this test then a second beam shall be taken from the same lot and similarly tested. If the second beam stands the test, it shall be optional with the inspector whether he shall test a third beam or not. If he does not do so,

or if he does, and the third beam stands the test, the 500 beams, or less, shall be accepted as filling the requirements of this test.

10. Individual beams will not be accepted which (1) do not conform to standard dimensions, and (2) those that have physical defects. Any lot of 500 beams, or less, submitted for test, that fail to meet the prescribed test (Par. 8) will not be accepted.

RECOMMENDATIONS.

Your committee further recommends for adoption by the M. C. B. Association as recommended practice:

1. That all beams be inside hung.
2. That all beams be hung 13 ins. from the rail.
3. That brake hangers shall be attached to the brake head at the center, and just back of the central brake shoe lug.
4. That brake hangers shall be ⅞ in. in diameter.
5. That brake hangers should have an angle as nearly as possible to 90 deg. from a line drawn from the center of the brake shoe to the center of the axle, when the shoes are half worn.
6. Third suspension hangers should be used on all brake beams. They should be attached to flexible brackets, and should have the same angle and length as the brake hangers.
7. For safety hangers, chains should be used.
8. That, in order that these specifications may be generally observed, after September 1, 1910, all cars not equipped with brake beams built in accordance with these specifications, be subject to rejection in interchange on account of improper equipment.

COMPOSITE DESIGN OF COUPLER.

Committee—F. W. Brazier, chairman; R. P. C. Sanderson, A. Stewart, T. S. Lloyd, C. E. Fuller, J. T. Chamberlain. Coupler manufacturers' representatives forming part of the committee—H. C. Buhoup, the Janney Coupler Company; Samuel Lewis Smith, National Malleable Castings Company; S. P. Bush, Buckeye Steel Castings Company; W. L. Jacoby, Latrobe Steel Coupler Company; F. P. Huntley, Gould Coupler Company.

The Special Committee appointed to confer with the Standing Committee on Tests of M. C. B. Couplers to consider the question of a composite design of coupler begs to submit the following report:

First it may be well to call attention to the duties of the Special Committee, which are outlined in the report of the Standing Committee on Tests of M. C. B. Couplers to the Master Car Builders' convention in June, 1905, which reads as follows: "That the Coupler Committee be empowered to act in conjunction with the specially appointed committee (in which should be included representatives of the manufacturers) to early decide upon a composite design of coupler which shall contain, as far as possible, the desirable features of the best couplers as now designed, and that all patent rights involved be waived and all manufacturers be permitted to manufacture the composite coupler as adopted."

The Special Committee is unanimous in its opinion on this subject, and you will note the instructions under which the committee was to work were very definite, concise and clear as to their meaning, leaving no latitude whatever, and after a thorough discussion of every phase of the subject that could be thought of, it was decided that the instructions could not be carried out and were impracticable at this time, and that the committee should report to the Standing Committee on Tests of M. C. B. Couplers and ask them for further instructions as to any further service said Special Committee could be in helping the Standing Committee along towards the general results which were aimed at by the Association in the formation of said committee.

It developed that of all the couplers currently bought and used in the United States to-day probably 90 per cent. were made by manufacturers who were represented on said committee.

It was agreed that only three or four of the couplers made (all of which were represented on said committee) complied reasonably well with the Interstate Commerce Safety Appliance Act; that none of said manufacturers were willing to give up their patent rights and surrender them to the Association. The reasons given by their side were principally twofold:

First—That we were asking them to surrender a considerable and valuable portion of their stock in trade, whereby they control the manufacture of the said couplers for their own benefit.

Second—That if the manufacture of said couplers were thrown open to any steel foundry or malleable iron foundry there would be no possible way in which the manufacture of inferior couplers, by any and every manufacturer, to the detriment of the standard manufacturers, could be prevented, the presence of which on the cars of the country would entail very great cost on the railroads, and be unfair to those who wished to purchase an efficient coupler complying with the specifications.

It was the consensus of opinion of the railroad representatives that it would be entirely unfair and not in accordance with business ethics to ask the manufacturers to surrender their rights without compensation, and that the Master Car Builders' Association is not a body which can properly acquire rights of this character and sell them or give them to manufacturers, without rendering itself liable to charges of unfair discrimination.

And further, that the adoption of such a standard as was proposed by the instructions would stop and impede progress in the coupler business, unless this work were undertaken by the Association, through the agency of the standing committee at the expense of the Association; whereas, now all reputable manufacturers spend considerable money yearly in developing and perfecting the couplers presented to railroad companies, thus meeting the increased demands of service without cost to the user.

It was agreed that it was a probable impossibility that any coupler could be designed which did not embody infringements on existing valid patents.

As the instructions required that the principal and best features of existing couplers shall be embodied in the design the committee was to work out, the position taken by the manufacturers blocked any possible action that could be taken by the committee.

As it seemed that the principal reason for the appointment of this committee was the trouble experienced by railroad companies to-day in keeping a stock of, and making repairs to, the very large number of patent couplers, and that this was the principal and real reason for the desired action, and as it was agreed that the existing couplers of many patterns could not be arbitrarily expunged from the cars, but would have to wear themselves out, it would be impossible, even if a standard coupler could be adopted to-day, to do more than gradually reduce the many patterns of couplers now in existence.

It was admitted and agreed that if we only had three or four kinds of couplers there would be no cause for complaint under this heading, and that other action would not be needed.

As it was shown, that for the reasons first mentioned the purchase of couplers had practically narrowed itself down to three or four makes, in this country, and the elimination of the many different patterns of couplers was already in progress, and that as the old couplers disappeared, renewals all being made by couplers of three or four makes, the principal source of annoyance now existing would be eliminated.

It was agreed that the second recommendation of the Standing Committee on Tests of M. C. B. Couplers, in its report to the M. C. B. Association at the convention held in June, 1905, which was "That the present policy of the Association be followed out; that is, that the gradual improvement of the M. C. B. standard coupler and the elimination of poorly designed and weak couplers be carried on as at present by making the requirements to be met by the M. C. B. coupler more and more rigid, thus compelling a higher degree of efficiency, and closely prescribing the limits for the future within which designers may work, while at the same time in no way preventing beneficial competition"—and which recommendation was not acted on by the convention—is far the best, and, in fact, the only plan which the Associaton can follow; that is, to have standard requirements for couplers and narrow these requirements down so as to limit the number of couplers which can successfully fulfil said requirements, and in this way drive out of the field inferior makes and multiplicity of patterns, leaving the field open for reasonable and honorable competition and development.

In concluding its report this committee strongly recommends that in the future no couplers be purchased by railroad companies unless they meet the requirements of the Master Car Builders' Association, and the recommendation of the Standing Committee on Tests of M. C. B. Couplers, as in this way the elimination of all couplers which do not fulfil the requirements would soon be effected.

TESTS OF MASTER CAR BUILDERS' COUPLERS.

Committee—R. N. Durborow, chairman; J. E. Buker, Theo. H. Curtis, F. H. Stark.

In view of the action taken by the Special Committee, your Coupler Committee would now recommend that the second proposition contained in the 1905 report of the Coupler Committee be adopted to govern the Standing Committee on Tests of M. C. B. Couplers for the ensuing year, which reads as follows: "That the present policy of the Association be followed out; that is, that the gradual improvement of the M. C. B. standard coupler and the elimination of poorly designed and weak couplers be carried on as at present, by making the requirements to be met by the M. C. B. coupler more and more rigid, thus compelling a higher degree of efficiency and closely prescribing the limits for the future within which designers may work, while at the same time in no way preventing beneficial competiton."

There are several slight inaccuracies and omissions in the M. C. B. drawings of standards and recommended practices in the Proceedings of 1905, for coupler and coupler yoke, to which your committee desires to draw attention as follows:

M. C. B. Sheet II. End view of coupler at bottom of sheet shows slotted instead of solid knuckle. As the solid knuckle has been adopted as standard, the drawing should be changed accordingly.

M. C. B. Sheet "B." Yoke for twin-spring gear and yoke for tandem-spring gear shows a dimension of 6⅛ ins. between legs of yoke. These yokes were designed for the 6½-in. coupler butt, and therefore this dimension should reach 6½ ins. The over-all dimension of 9 ins (over legs of yoke) is correct, and the 6⅛ ins. is a typographical error and should be corrected.

M. C. B. Sheet "B." There is no 5 by 5½ by 6½-in. butt shown on this sheet with 1 5-16-in. holes for the 1¼-in. rivets adopted as recommended practice. Inasmuch as the yokes are shown for this size butt, the coupler butt should be included on this sheet.

PRICES FOR REPAIRS TO STEEL CARS.

Committee—T. H. Russum, chairman; R. F. McKenna, E. B. Gilbert, R. W. Burnett, G. N. Dow, W. F. Eberle, James Macbeth.

After very thoroughly going into this matter, the committee would recommend that Rule No. 106, page 43, of the 1905 Code of Rules, be changed to read as follows: "All rivets, 10 cents per rivet, which covers removal and replacing of rivets, including removing, fitting, punching or drilling holes when applying patches or splices, and replacing damaged parts, not to include straightening or repairing. Straightening or repairing parts removed from damaged car, 50 cents per 100 pounds. Straightening or repairing parts in place; also any parts that require straightening, repairing or renewing, not included on rivet basis, 20 cents per hour. Credit for scrap material removed from cars constructed of pressed steel or structural steel, ½ cent per pound."

AXLE LIMITS.

Committee—E. D. Nelson, chairman; J. H. Manning, C. D. Pettis.

The load carried on the axles is made up of the light weight of the car and the weight of the lading, from which would properly be deducted the weight of wheels and axles, as the weight of these is not transmitted to the journals. The standard axles are designed to carry stated loads, and not for cars of stated capacities. A comparatively light car body carried by axles of designated size is entitled to a larger weight of lading than a heavier car body on the same axles. It is undoubtedly true that when the capacity of a car is made the basis of axle diameters, regardless of the weight of the body, comparatively light cars are not carrying as much lading as they should; and, further, that axles are, in some cases, overloaded where the car body is excessive in weight and the marked capacity is not reduced accordingly.

Your committee, therefore, proposes that the present method of marking cars be changed, and that all cars ultimately should be stenciled with LIGHT WEIGHT and MAXIMUM WEIGHT. The former is, of course, the present light weight as used on all cars. The latter is the limiting weight that should be carried on four axles, depending, of course, on their diameters. It is not thought that shippers or others will be seriously inconvenienced by this change, and, on the contrary, the benefits to the railroads will be considerable.

The table entitled "Limits of Axles Based on Maximum Weight of Car" shows the present nominal capacity, the designation of each of the M. C. B. standard axles, and the load each was designed for. To this latter weight may be added the weight of wheels and axle itself, in order to arrive at the permissible weight per axle at the rail, as given in the fifth column. The permissible weight multiplied by 4 gives the total permissible weight at the rail for a car with 4 axle , and column 7 gives, in round numbers, the proposed MAXIMUM WEIGHT as recommended by your committee.

It will be noted that for cars of nominal capacity of 80,000 lbs., the only change is in the center of axle "C," which should be increased 1-16 of an inch. For 70,000-lb. capacity cars it is proposed to increase the limits for all diameters of the axle. For cars of 60,000, 50,000, 40,000 and 30,000 lbs. capacity, the limiting diameters for wheel seat and center would have to be increased. For cars of 20,000 lbs. capacity the limiting diameter of center only should be increased.

It should be understood, in the plan proposed, that the limiting diameters as now given in Rule 23 would hold good for all cars having CAPACITY marks, but that where the marking on cars is changed to show LIGHT WEIGHT and MAXIMUM WEIGHT the proposed limits, as shown in the table mentioned, would hold good. It is naturally assumed that cars having the older designs of axles will continue to have capacity marks up to the time when the axles under them may be changed to the standard axles, at which time the capacity marks would be removed and the MAXIMUM WEIGHT substituted.

Assuming that the plan above described meets with the approval of the Association, it would appear necessary to make modifications in both Rules 23 and 74, and the recommendation of your committee is that they should be changed to read as follows:

"RULE 74. When second-hand axles are applied under conditions which make them chargeable to the owners, the diameters of the wheel seats and center must not be less than, and the diameter of the journal must be ¼ in. greater than the limiting diameters given in Rule 23. If cars are marked with the word 'Capacity,' the first set of limits must be followed. If cars are marked 'Maximum Weight,' the second set of limits must be followed."

"RULE 23. Axles less than the following prescribed limits:

FOR CARS MARKED WITH "CAPACITY."

Capacity of Car.	Journal.	Wheel Seat.	Center.
100,000	5 ins.	6¾ ins.	5⅞ ins.
80,000	4½ ins.	6¼ ins.	5 5-16 ins.
70,000	4 ins.	5⅝ ins.	4⅞ ins.
60,000	3¾ ins.	5 ins.	4⅜ ins.
50,000	3½ ins.	4¾ ins.	4⅛ ins.
40,000	3¼ ins.	4⅝ ins.	3⅞ ins.
30,000	3 ins.	4¼ ins.	3½ ins.
20,000	2¾ ins.	4¼ ins.	3½ ins.

FOR CARS MARKED "MAXIMUM WEIGHT."

Maximum Weight.	Journal.	Wheel Seat.	Center.
161,000	5 ins.	6¾ ins.	5⅞ ins.
132,000	4½ ins.	6¼ ins.	5⅜ ins.
112,000	4¼ ins.	6 ins.	5¼ ins.
95,000	3¾ ins.	5½ ins.	4¾ ins.
79,000	3½ ins.	5¼ ins.	4⅝ ins.
66,000	3¼ ins.	4⅞ ins.	4¼ ins.
58,000	3 ins.	4¾ ins.	4⅛ ins.
46,000	2¾ ins.	4¼ ins.	3¾ ins.

"All cars to have their light weight and capacity or their light weight and maximum weight stenciled on them."

TANK CARS.

Committee.—A. W. Gibbs, Chairman; C. M. Bloxham, Robert Gunn.

The Executive Committee, recognizing the fact that the present Recommended Practice of the Association is in some respects not adapted to the present state of the art, under date of February 12, 1906, reappointed the former committee with request that revised specifications be submitted for consideration as Recommended Practice.

The necessity for this has already been brought to the attention of railroads which have issued circulars on the subject of tank car interchange, and the reccomendations submitted are taken almost bodily from one of the railroad circulars, which circular was issued after joint conference of a number of roads issuing similar circulars.

The general specifications consider the trucks, brakes, safety appliances, attachment of the tank to the frame and the tests of the tank. Following this are the specifications for the application of safety valves and the requirements for old tank cars, having wooden underframe and for new tank cars. Mention is made of the fact that the Pennsylvania Railroad Company has patented a design which fulfils the requirements for new tank cars. After having this passed upon by the Eastern Railroad Association to make sure that such a car could be constructed without liability of patent infringement, the railroad company dedicated it to the use of the public. (AMERICAN ENGINEER, March, 1906, page 83.)

HIGH SPEED BRAKES.

Committee—F. M. Gilbert, chairman; C. B. Young, M. Dunn, J. J. Hennessey.

Your special committee, appointed to look into the question of our recommended practice for high speed foundation brake gear for passenger equipment cars, begs to report as follows: We have looked carefully into the matter and find that the gear for four-wheel trucks is satisfactory. There are, in our opinion, some small changes in the gear for six-wheel trucks which should be made before it is passed to M. C. B. standard. The objects to be accomplished by these changes are: Means for taking up by hand the slack, which accumulates from brake shoe and tire wear, more quickly and in smaller increments than is now possible. Your committee have in service an arrangement for accomplishing these results, but the information so far collected is not sufficient to warrant them in making definite recommendations covering the six-wheel truck. The committee would, therefore, respectfully ask for another year in which to complete its investigations.

LIMITS FOR AXLES BASED ON MAXIMUM WEIGHT OF CAR.

Nom. Cap. of Car. Lbs.	Axle.		Weight of Axle and Wheels.	Permissible Weights per Axle at Rail.	Permissible Weights of Car and Lading at Rail.	Proposed Maximum Weight of Car and Lading at Rail.	Limiting Dimensions. Journal.		Wheel Seat.		Center.	
	Designation.	Load. Lbs.					Calculated.	Proposed.	Calculated.	Proposed.	Calculated	Proposed.
100,000	D	38,000	2,200	40,200	160,800	161,000	4.75	5	6.70	6¾	5.73	5⅞
80,000	C	31,000	1,925	32,925	131,700	132,000	4.32	4½	6.21	6¼	5.32	5⅜
70,000	C	26,000	1,925	27,925	111,700	112,000	4.15	4¼	5.89	6	5.03	5¼
60,000	B	22,000	1,675	23,675	94,700	95,000	3.71	3¾	5.48	5½	4.67	4¾
50,000	B	18,000	1,675	19,675	78,700	79,000	3.43	3½	5.22	5¼	4.51	4⅝
40,000	A	15,000	1,450	16,450	65,800	66,000	3.10	3¼	4.80	4⅞	4.09	4¼
30,000	A	13,000	1,450	14,450	57,800	58,000	2.97	3	4.58	4¾	3.90	4⅛
20,000	A	10,000	1,450	11,450	45,800	46,000	2.72	2¾	4.19	4¼	3.57	3¾

LOCATION OF TEMPORARY STAKE POCKETS.

Committee—A. Kearney, chairman; C. E. Fuller, A. Stewart. F. H. Clark, T. H. Curtis, J. S. Lentz, W. F. Keisel, Jr., L. H. Turner.

Your committee had scarcely hoped to be able to recommend a standard location for temporary stake pockets or even a location for a recommended practice; but, through the kindness of some of the pipe manufacturers who have manifested a particular interest in this work, have been able to secure a suggestion that would seem to at least satisfy that class of traffic, and incidentally would accommodate lumber shipments except loads handled on twin and triple cars, where it is required they be spaced, from center to center, not less than 2 ft. nor more than 3 ft. 6 ins., as referred to in Rule 48. The latter, however, is somewhat special, and refers to a shipment usually handled on flat cars, where the stake pockets are but seldom in excess of that measurement.

The cut (not reproduced) shows the longitudinal spacing for temporary side stake pockets, which are spaced 5 ft. center to center.

LOCATION OF SIDE AND END LADDERS ON BOX AND STOCK CARS.

Committee—W. E. Fowler, chairman; Joseph E. Buker, F. H. Clark, T. H. Curtis, W. R. McKeen.

We believe it is the general practice to locate the roof grab irons parallel to the side or end of the car on which the ladder may be placed, and are of the opinion that this roof grab iron is a sufficient indication as to the location of the ladder. We recommend that the Committee on Standards be instructed to modify the M. C. B. sheets and rules covering the location of grab irons to *show* the roof grab irons parallel to the side or end of the car on which the ladders are located, these grab irons to be placed between the limits of 12 or 15 ins. from the edge of the car.

(Additional Reports will appear next month.)

MASTER MECHANICS' ASSOCIATION.

ABSTRACTS OF PAPERS AND REPORTS.

Classification of Locomotive Repairs.

Committee—H. H. Vaughan, chairman; A. E. Mitchell, R. Quayle, D. Van Alstyne.

Your committee appointed to recommend a uniform system of classification of locomotive repairs considers this subject to properly comprise the following three separate questions:

1. A classification distinguishing between those engines which are in service and those which are under repair.
2. A classification distinguishing between those engines which are under running repairs and those which are under shop repairs.
3. A classification distinguishing between the various classes of shop repairs.

The distinction between engines in service and those under repair was, some years ago, very generally made by considering all engines in service which were not under or waiting repairs at a main shop or undergoing light overhauling at a roundhouse, and this practice, which is in many ways satisfactory, is still in force on many roads. With the increasing demands on an operating officer for obtaining the maximum service from the power assigned to him, it has become customary to establish some limit to discriminate between those engines from which he should be expected to obtain service, and those which, although not actually shopped, are held at the roundhouse for a sufficiently long time to make it unreasonable to include them in calculating the average daily mileage. As it is recognized that engines must receive small repairs from time to time, it is evidently simply a matter of agreement as to where the prescribed line should be drawn, but in view of the comparisons that are frequently made between one road and another as to the percentage of their power that is available for service, a uniform definition of this limit is important if such comparisons are to be of any value.

The distinction between running and shop repairs is at present largely a question of individual preference. Several roads have, however, already arranged their locomotive performance sheets to show the costs of these two divisions separately, and as this is of considerable importance in statements attempting any accurate comparison, it would be of indubitable advantage if uniformity could be secured.

The distinction between the various classes of shop repairs is made for two purposes: first to indicate in a general way the nature and extent of the repairs made to an engine, and, secondly, to allow of a rough measure being obtained of the output of a repair shop. In neither of these cases is a close definition possible without more complication than is either practicable or desirable. The detail repairs vary to such an extent on engines between which differences cannot be specified in any classification having a reasonable number of headings that, for the purpose of accurate comparison, either of one shop with itself, or of the various shops on a system, the costs or times required for specific operations must be dealt with, and not those of the accumulation of a number of those operations which may not correspond within wide limits even on engines which, as closely as possible, would be said to receive the same class of repairs. There would thus be but little advantage in the use of a uniform classification of shop repairs, and the object of this report is consequently to discuss the various systems employed and point out their respective advantages.

To obtain information as to the practice existing in the above respects, a letter of inquiry was issued, replies to which are tabulated below:

Name of Road.	Limit distinguishing between engines in service and those under repairs.	Limit distinguishing between running and shop repairs. Tires not turned.
Atchison, Topeka & Santa Fe	24 hrs. from arrival	$50.00
Atlantic Coast Line	When wanted for run	
Baltimore & Ohio	If held for any repairs	$25.00
Buffalo, Rochester & Pittsb.	24 hrs. from arrival	Wk. done in r'dh.
Canadian Pacific	24 hrs. from arrival	$100.00 labor.
Canadian Northern	24 hrs. from arrival	Not out of ser'e.
Central Railroad of N. J.		
Chesapeake & Ohio	12 hrs. from arrival	$300.00.
Chicago & Alton	24 hrs. from time arr'd.	$50.00.
Chicago & North-Western	Not ready when wanted.	Roundh'se work?
Chicago, Burlington & Quincy	Shop repairs	$250.00.
Chicago, Milw'kee & St. Paul	24 hrs. from time arr'd.	Tir's, flu's or $200
Delaware & Hudson	24 hrs. from arrival	$100.00.
Denver & Rio Grande	24 hrs. from arrival	
Duluth, So. Shore & Atlanic	24 hrs. from arrival	None.
Grand Rapids & Indiana	Shop repairs	Tires or $10.00.
Illinois Central	Five days	$100.00.
Lake Shore & Mich. South'n	4 days from arrival	R'd'e class of wk.
Mexican Central	24 hrs. after arrival	None.
Minneapolis & St. Louis	Not ready when wanted.	Roundh'se work.
Northern Pacific	24 hrs. from arrival	$400.00.
New York, Ontario & West'n	24 hrs. from arrival	By money value.
Pennsylvania Lines West	24 hrs. from arrival	$10.00.
Seaboard Air Line	24 hrs. from 7 A. M.	Not out of ser'e.
Southern Pacific	Held for rep'rs o'er $75.	$75.00.
Union Pacific	Held for rep'rs o'er $75.	$75.00.

I.

The committee recommends that engines should be considered as under repairs if not ready for service within twenty-four hours of their time of arrival at the roundhouse, or in the case of engines assigned to regular runs or in helper or switching service, if not ready for their run.

II.

A classification distinguishing between those engines which are under running repairs and those which are under shop repair.

The table shows very little agreement with reference to the distinction between running and shop repairs, and illustrates, what has previously been mentioned, that this is very largely a question of individual preference. In its broadest sense the division should be made by terming those repairs which are incidental to the maintenance of an engine in service and the amount of which is approximately proportional to the miles run by the engine, running repairs, and those in which a number of the parts of an engine are repaired or renewed to place it in condition for making a further number of miles, shop repairs. The amount of the shop repairs is evidently independent of the miles run in the month during which they occur, and its nature is that of an occasional as against a continual maintenance charge. A further condition must also be observed, that repairs of sufficient magnitude to be individually worth analysis should be considered shop repairs, as running repairs are very generally reported as a total monthly sum and no record kept of the cost of each shopping. On some roads this represents simply the difference between work done in the shop and in the roundhouse, while on others, where main shops are conveniently situated, it is quite usual to do repairs in them that are essentially running repairs, while in many cases, also, work of considerable magnitude is handled in the roundhouse; and to obtain uniformity some more definite limit than this must be established.

While this cannot be done with any logical accuracy, it is evidently in accordance with general practice to define it by the amount of money expended, and, if accounts are to show the cost of running and shop repairs separately, it is preferable that this represent the estimated rather than the actual cost.

In that case, when an engine is reported under repairs it is at the same time reported as under shop or running repairs, as the judgment of the foreman may determine, and the cost of the work booked accordingly. On this account there is also an advantage in basing the limit on the value of the labor expended, in place of on the total of material and labor, as it can in general be more closely estimated, and in repairs of this nature the cost of the labor is also a better indication of the extent of the repairs effected than is the total cost of material and labor. On this basis your committee considers it may be stated that repairs on which the labor is under $50 might safely be described as running repairs, while those on which it is over $100 would certainly be of sufficient importance to warrant them being individually reported and considered as shop repairs; and in view of the constantly increasing size of locomotives and the desirability of avoiding unnecessary complication it would select the higher limit as preferable.

Running repairs are those, whether made in shop or roundhouse, in which the estimated labor does not exceed $100.

III.

A classification distinguishing between the various classes of shop repairs.

The system in use for classifying shop repairs varies with each road or group of roads reporting. What may be termed the money system is in extended use, in which the class of repairs is graduated by their cost, varying frequently with the size of the engine. It is difficult to see what object is served by a classification of this nature, as it affords no information as to the work done on the engine, and the shop output can only be measured by the total sum expended. If, for instance, on any class of engine a No. 2 repair is defined as one costing between $1,500 and $1,000, while a No. 3 costs between $1,000 and $500, and one shop is doing the same class of work for $900 that another does for $1,100, the first shop would only receive credit for a No. 3 repair, while the other would be credited with a No. 2, so that evidently this method is of no use as a measure of output. It may be objected that no classification can be of any use, but this would appear to be about the only argument justifying a classification by cost.

The simplest, and what may be termed the most primitive, method is that where repairs are classified as light, general and heavy, but it is evident that such a classification does not afford specific information with regard to the work done, whether tires were turned, tubes reset, and the extent to which the machinery and boiler was repaired. It has therefore been developed by increasing the number of classes up to six or eight, each class defining such combinations of repairs as are found to usually accompany each other. A good example of this system, which may be termed the numerical, and which is representative of that used by many roads, is herewith presented:

Class 1 repairs contemplate a new boiler, and all necessary work in addition thereto.

Class 2 repairs cover new firebox, tires turned or renewed if necessary, and all necessary machinery repairs.

Class 3 repairs; all flues reset or renewed, tires turned or renewed, and necessary machinery repairs.

Class 4 repairs; flues reset or renewed, either full or part set, and necessary repairs to machinery.

Class 4a repairs; one-third or less flues reset or renewed, tires turned or renewed, and necessary machinery repairs.

Class 5 repairs; tires turned or renewed, and such machinery repairs as are necessary.

Class 5a repairs; any repairs which are not included in the above classes, except accident repairs. Class 5a repairs is generally machinery repairs of which the labor cost amounts to more than $10.

Class 6 repairs; repairs which are due to accident and for which the motive power is not responsible.

This type of classification has the objection that in spite of the number of classes of repairs, the information obtained is quite indefinite. The classes of repairs Nos. 1, 2, 3, 4 and 5, inclusive, vary simply according to the amount of boiler work performed, and the information obtained is that tires have been turned and machinery repaired with the following boiler work:

Class 1, new boiler.
Class 2, all tubes reset.
Class 3, new firebox.
Class 4, one-third or less tubes reset.
Class 5, no tubes reset.

No distinction is thus made between an engine having side sheets and front tube sheet removed and one in which no firebox work is done, and it would certainly appear that such differences should be recognized in any classification for the purpose of obtaining definite information. A further objection is that Classes 4 and 5 are the only ones in which any distinction is made as to the extent of the machinery repairs, as in those classes tubes are not turned or renewed; but otherwise no information is obtained as to whether machinery repairs are light or heavy, and in view of the common practice of giving engines intermediate repairs to machinery, it would certainly be an advantage to indicate what was done. It would, however, on this system introduce at least three additional classes, as Classes 3, 4 and 5 repairs might each include light or heavy machinery repairs. If this were done there would then be ten classes of repairs, without including those required if the firebox work was more closely specified, and the tabulation of those to present any intelligent comparison of shop output would certainly be exceedingly difficult. While, no doubt, the system has worked exceedingly well, especially on roads where the conditions were more or less uniform and the repairs were very generally capable of classification under two or three numbers, it has evidently the fault of specifying by a number each combination of repairs to boilers and machinery, and necessarily becomes complicated if the combinations vary from time to time.

An analysis of this system shows that the various elements entering into the above classification are as follows:

1. New boiler.
2. New firebox.
3. All flues reset.
4. One-third or less flues reset.
5. No tubes reset.
6. Machinery repairs with tires turned.
7. Machinery repairs without tires turned.

These various elements have been combined in seven different ways covering those most likely to occur in service, but from the above discussion other elements might with advantage be introduced as follows:

8. One firebox sheet renewed.
9. Two firebox sheets renewed.
10. Three firebox sheets renewed.
11. Four firebox sheets renewed.
12. Tires turned with general repairs to machinery.
13. Tires turned with light repairs to machinery.

When this is done the number of combinations that may occur becomes far more numerous, as either 8, 9, 10 or 11 may occur with 3, and with either 12 or 13 into which 6 has been divided, and as information as to these elements is certainly required to define the repairs received by an engine, the numerical system practically becomes unwieldy, and it has on several roads been developed into the divisional system in which a combination of letters or numbers is used to indicate the repairs received.

An inspection of the various elements enumerated above shows that they may be divided into three divisions—machinery, tubes and firebox, as follows:

Machinery repairs:
1. General repairs to machinery with tire turning.
2. Light repairs to machinery with tire turning.
3. Light repairs to machinery without tire turning.

Flue repairs:
1. All reset.
2. Part reset.

Firebox repairs:
1. One sheet.
2. Two sheets.
3. Three sheets.
4. Four sheets.
5. Five sheets.

On the divisional system, in place of specifying certain combinations of these elements and assigning a number to each combination, the class of machinery tubes and firebox repairs effected are mentioned separately, as, for instance, an engine having a general repair to machinery, all tubes reset and two firebox sheets renewed is said to have a No. 1 machinery, No. 1 tube and No. 2 firebox repair. This may be abbreviated to M. 1, T. 1, F. 2, or more simply to 1-1-2, providing zero is understood to mean no repairs, and the class of repairs received by an engine within the limits of definition included in the list of elements is thus concisely and clearly determined. It is evident that this system does not attempt any closer definition of the class of repairs received than does the numerical, but it states them in a more convenient way, and also enables reports to be more closely arranged.

The heading required for reporting engines receiving repairs at any station is as follows:

Engine Number.	Class of Repairs.			Other Information as Required.
	M.	T.	F.	
1,000	1	1	2	

The statement of engines turned out at various points during any period is as follows:

Shop.	Machinery.			Tubes.		No. of Firebox Sheets.	Other information as to days or under repairs, running repairs, etc.
	1	2	3	1	2		
New York	17	12	8	22	1	12	

It will be noticed that the report of engines receiving repairs defines the work done to each engine, while the statement showing the repairs made at each shop does not connect the repairs made to each engine, but simply summarizes the amount of work turned out.

This summary does, however, show the number of general, intermediate and light machinery repairs each period, the number of tubes reset or part set, and the total number of firebox sheets applied, and thus affords as clear a statement of shop output as can be obtained without going into greater detail, and also, when totalled for all shops in a district, enables a fairly close estimate to be made, as to whether the required amount of shop work on the system is being obtained.

It may be objected to, and with good reason, that a classification of this nature does not define the repairs received with sufficient accuracy to allow of fair comparisons to be drawn; as, for instance, one engine receiving No. 1 machinery repairs may require a new driving axle, a new pair of cylinders and frame taken down, while another receiving the same class of repairs may not require any of those especial items, or that a firebox sheet may mean a flue sheet on one engine and a side sheet on another; but the only answer can be that any system going into such details would become so complicated as to defeat its object, and that such information must be obtained from the work report and not from the statement of shop repairs.

The latter is and should be a general summary, and the explanation of the amount of work performed can safely be left to the man whose output is not fairly allowed for.

One important point to consider is the allowance that should be made for the size of the engines repaired, as it is obviously true that the large and heavy locomotives now being used cannot be either repaired or maintained for the same amount as smaller engines. From the point of view of the shop alone probably the best comparative unit for this purpose would be the weight of the engine, as this determines the amount of material it is composed of, and is consequently a measure of its cost and also of the cost of the labor necessary to repair it. There are, however, many reasons for using a unit for repairs which is also to be used for general purposes, and your committee feels that, while not strictly included in this subject, reference may be made to the tractive power mile introduced by Mr. A. A. Goodchild, when auditor of statistics on the Canadian Pacific Railway, which has many advantageous features. On that road the tractive power is expressed in the usual way as a percentage, an engine shown as 100 per cent. having a drawbar pull of 20,000 lbs. calculated at 85 per cent. of the boiler pressure. An engine having a tractive power of 30,000 lbs. is shown as making 1.5 100 per cent. miles for each mile it runs, and the cost of repairs is calculated both for the locomotive mile and the 100 per cent. locomotive mile. This unit is also used in a number of other ways, but the above example will illustrate its principle. The test of two or more units is their approximation to the truth, and in comparing those suggested for the comparison of locomotive repairs, the miles, the engine ton-mile and the tractive power, or, as it may be called, the 100 per cent. mile, the mile may be first eliminated, since with engines varying in weight in the ratio of three to one it is evidently inaccurate. Considering the 100 per cent. mile as against the engine ton-mile, if two engines weigh the same, but one is a consolidation, the other a ten-wheeler, the consolidation will cost more to repair. On the engine ton-mile basis the allowance would be the same, on the 100 per cent. mile basis the consolidation will obtain a greater allowance, which will to a certain extent compensate for its greater cost of upkeep. If, again, two engines of equal weight are compared, one passenger and one freight, the freight engine will cost the larger sum per mile. On the 100 per cent. mile basis this is partly compensated for by the increased tractive power, and this unit may therefore be said to be the closer. Your committee does not consider it necessary to define the tractive power which constitutes 100 per cent., as that is unimportant, provided it is known and allowed for; but in view of the merits of the tractive power or 100 per cent. mile as a unit, it would recommend that the same unit be used in allowing for the output of a shop. By including this factor the statement of engines receiving repairs at any point in place of showing the number of engines actually receiving No. 1, 2 and 3 machinery repairs, etc., would show the equivalent number of 100 per cent. engines receiving such repairs, and a 50 per cent. engine counting as 0.5 and a 150 per cent. engine as 1.5 100 per cent. engines turned out, and so on, and your committee then considers that the output of the various shops would be measured as closely as is practicable without objectionable complication.

Locomotive Lubrication.

Committee—E. D. Bronner, chairman; R. F. Kilpatrick, C. Kyle, R. D. Smith.

This subject is of vital importance to every railroad company, and, as the information at hand does not warrant us to draw definite conclusions in all cases, the report should be considered as a preliminary one.

The committee, in investigating the subject, divided the work, so that each member could devote his time to one phase of the subject. Consequently the report represents the combined effort of the committee.

A PROPER LUBRICANT FOR HIGH STEAM PRESSURE AND SUPERHEATED STEAM.

For locomotives with steam pressure as high as 225 lbs., or those using superheated steam, the temperature of which is as high as 600 deg. F., the ordinary valve oil has been found by experience to be quite satisfactory. The problem is to deliver the oil in proper quantities to the place where needed.

ECONOMY IN INTERNAL LUBRICATION.

In order that the engine parts may perform their work properly and without undue wear or heating, lubrication here should not be stinted. Dry valves and cylinders mean rapid wear of the surfaces of contact in the steam chest and cylinders, besides excessive trouble with the valve motion parts. An attempt to get even at the minimum of oil used for internal lubrication is apt to result in hot or slipped eccentrics, and broken eccentrics, eccentric straps, links, transmission bars, rockers, valve stems and connection pins, in addition to the trouble just mentioned. Aside from increased machine friction, the performance of the engine is affected. Hard running valves cause a derangement in steam distribution; and worn packing in valve chambers, cylinders, or at rods, causes a loss due to leakage.

With the slide valve locomotives there is not so much danger of these troubles becoming excessive, because the jar of the reverse lever is such an annoyance to the engineer that he at once exerts his energy to seeing that the valves are properly lubricated.

With piston valve locomotives the internal lubrication may be much below that required without any indication from the reverse lever. Under these conditions the annoyance comes to the man responsible for maintaining the locomotives, and the cause of the trouble may have been operating for a long time before being discovered, or indeed may be lost sight of altogether. In other words, with slide valve engines, when the oil allowance is just sufficient or only a little in excess of what is needed, the engineer is more apt to keep the valves supplied with enough oil to prevent hard service to the machine; while, with the piston valve engines he is not so able to tell that the valves need oil, and no one knows that the parts have been running too dry until trouble comes through heated bearings, or worn and broken parts.

Summarizing: For internal lubrication seventy miles per pint for large freight locomotives and eighty miles per pint for large passenger locomotives, would seem to be the amount needed to lubricate properly. The amount to each class depending upon the speed at which the locomotive is running. In bad water districts the oil allowance should be increased about 25 per cent.

ECONOMY IN EXTERNAL LUBRICATION.

The use of grease on crank pins and driving axles seems to offer the best solution of how to decrease the cost of external lubrication, and at the same time secure the better results.

Information gleaned from four years' experience with 203 locomotives, fully equipped for grease lubrication during all or part of that time, would indicate that to lubricate pins and driving axles with grease instead of oil reduces the cost of external lubrication. Along with the reduction in cost there has been a decided decrease in engine failures due to hot bearings. Journals lubricated with grease are less apt to be cut, and cut journals require turning. Hence grease lubrication increases the mileage between turning of axles and pins. The action of a grease lubrication system applied to driving boxes is practically automatic. On this account its action is independent of whim or neglect of the engineer, and it applies lubricant at the time it is needed in approximately the right quantities. Some objection has been raised to the use of grease as a lubricant on account of increased machine friction. Within the experience of your committee it has never been found necessary to reduce the tonnage rating of a locomotive on account of changing from oil to grease. It would seem, therefore, the reasonable conclusion that this effect is slight, and in view of the material advantages coming from the use of grease, need not be considered.

As a general résumé of this phase of the subject, grease as a lubricant on locomotives gives results about as follows:

(a) Reduces engine failures due to heated journals and pins.
(b) Reduces cost of lubrication.
(c) Reduces cost of labor incident to inspection, cleaning and renewals of lubrication packing.
(d) Reduces delays incident to oiling.
(e) Reduces cut journals incident to oil lubrication.
(f) Possibly produces a slight increase in machine friction.

THE CONSIDERATION OF STANDARD FITTINGS FOR LUBRICATORS.

To facilitate the use of different lubricators on the same railroad we would propose a standard as to relative location of holding arm shoulder and oil and steam connection joint faces; and a system of standard fittings and joints for all connections.

LUBRICATORS VS. PUMPS.

Data collected from twelve different systems would seem to indicate that pump lubricators of whatever description are still in a state of imperfection, and that quite as good results have been obtained by using the ordinary sight feed lubricator, even on superheated locomotives.

SUPERHEATED STEAM ON AMERICAN LOCOMOTIVES.

INDIVIDUAL PAPER, BY MR. F. J. COLE.

The theory of the superheater has been presented by Mr. H. H. Vaughan, in his paper before this Association last year. The general subject of superheating, as applied to locomotives, was admirably presented by Dr. W. F. M. Goss before the Franklin Institute in February, 1905, and published in the September journal of that body. In his paper on "Superheated Steam on the Canadian Pacific Railway," presented before the New York Railroad Club in April, 1906, Mr. H. H. Vaughan recorded the results of service experience with a very large number of superheaters on that road. No attempt will be made here to go over the ground so well covered by others.

At the present time it can be asserted confidently that the application of the superheater to American locomotives has come to stay. A sufficient time has now elapsed since its more extended application, which has taken place in the last three or four years, to justify this assertion. The locomotives so equipped have been distributed over a sufficiently wide area to include, generally, all sorts and conditions of service, so that the various kinds of fuel, water, local conditions, etc., necessary to consider in the successful working of locomotives, have been included in these trials.

While some discouraging conditions, such as the accumulation of iron slag on the outside ends of the superheater tubes, caused apparently by an excess of iron in certain grades of coal, have been met with in two or three instances, yet on the whole the consensus of opinion from various railroads confirms the statement that superheating, as applied to locomotive engines, is correct in principle and theory. The economies obtained in fuel and water are considerable, and superheating, generally, may be considered as a substantial improvement in the operation of locomotives under American conditions.

Following the practice abroad, force feed lubrication was at first considered necessary, and the principal makes of these lubricators, both foreign and domestic, were used in order to determine which kind was best adapted for the purpose. Experience has shown that the usual type of sight feed lubricators, with independent feeds to each inlet of the cylinders, give very good results and the valves and cylinders, on a number of superheater locomotives now running are successfully lubricated in this manner. Two lubricators are usually employed, with three feeds for each cylinder, two of the feeds going to the ends of the piston valves and one to the center and top of the cylinder barrel.

The temperature of saturated steam at 200 lbs. pressure is 387 deg., and with 150 deg. of superheat, the temperature of the steam will be 537 deg. It would appear that this is somewhat higher than the flashing point of the valve oil in regular use and it is probable that some of this is vaporized before the valves and metal surfaces are properly lubricated. This is offered as a possible explanation of the slight increase in oil consumption in lubricating valves and cylinders of locomotives equipped with superheaters.

The circulation of steam in the type of superheater which the American Locomotive Company first developed was produced by an internal circulating tube, commonly known as a Field tube. The boiler or fire tubes were 3 ins. O. D., the superheating tubes 1¾ ins. O. D. and the circulating tubes 1 1-16 ins. O. D. This style of superheater was the first one applied by the American Locomotive Company to a New York Central Atlantic type engine in June, 1904, and is illustrated in the AMERICAN ENGINEER of September, 1904, page 338. This superheater is still in service, and the locomotive to which it is applied is running fast express trains between Albany and New York.

A similar arrangement with the same size tubes was soon after applied to some Canadian Pacific consolidation locomotives. For a few subsequent applications the fire or boiler tubes were increased to 3½ ins., with a view of raising the temperature by increasing the area of the flow of the gases.

In the majority of cases the later forms of superheater applied by the American Locomotive Company have been of the return bend system, with boiler or fire tubes 5 inches O. D., and four superheating tubes 1¼ ins. O. D., 15-16 in. I. D., united in pairs at the firebox end with return bends. A much larger number of locomotives have been equipped with this later arrangement than with the original circulating tubes, and some sixty equipped in this manner are now in successful service. An average superheat temperature of 130 deg. has been usually obtained by this arrangement in passenger service. The temperature was taken at the steam chest by means of accurate instruments, and for this purpose high-grade thermometers with the bulbs immersed in tubes containing heavy oil were used.

With this degree of temperature substantial economies in fuel and water have been obtained. A later development of this style of superheater is shown in Fig. 1, in which the joints between the vertical headers and tee pipe are made by means of cast-iron ball-joint rings, each header having independent bolting, so that it may be put in place or removed without interfering in any way with the others. One advantage of this design is that in case any of the large boiler tubes require resetting at the front end, or renewing, it can be readily done by the removal of one section without interfering with the rest of the apparatus. The independent or sectional vertical headers are especially designed with this end in view. The tubes at the firebox end are connected together by return bends, funnel shaped, presenting the least possible obstruction for the accumulation of slag or cinders. For the ready removal of any foreign substance, it can be easily seen that a flue auger or cleaning rod may be used and the flues freed from accumulations to better advantage with this form than with an ordinary return bend. The design of this is shown in Fig. 2. The joints of the superheater pipes with vertical headers are made by the simple method of expanding by means of a roller in a similar manner to ordinary boiler tubes, the roller for this purpose being inserted in the hole in the front of the header, which is afterward closed with a screw plug with square end.

TESTING APPARATUS.—For the development of the latest design, a testing apparatus was constructed so that the efficiency of various forms of superheating tubes could be demonstrated. Briefly it consists of a 12-inch wrought-iron pipe 20 ft. 11 ins. long, closed at the ends with flanges and heads. In the center of these heads a single 5-inch O. D. pipe is expanded to represent one complete unit of the apparatus, as applied to a locomotive. At one end it is provided with a sheet-iron box to represent the smoke-box of a locomotive, and to contain the saturated and superheated steam headers. The 12-inch tube was filled with hot

water under pressure connected to a stationary boiler. At the other end a small oil burner, similar to those used in shop furnaces, was used. A tank mounted on a platform scale, containing oil, was connected by means of rubber hose and provided with air pressure for atomizing the oil. Thermometers were inserted at different points to measure the temperature. The saturated steam was kept at a uniform temperature and arranged to enter and discharge through diaphragms of uniform dimensions. A calorimeter was used for determining the amount of moisture in the steam and the test generally conducted so as to eliminate, as far as possible, all errors.

pany with a similar form of superheater, but some improvements have since been made in the joints and bolting. These are working well and showing economies at least equal to compounds.

Absolute perfection of detail is too much to expect in so short a time in the application of so radical a principle. Since the theory of a superheater was presented before this Association last year, facts from experience have become available which tend to confirm the opinion that future locomotive development is to include this principle.

This opportunity to comment upon the very satisfactory attitude of the Canadian Pacific Railway toward superheating must not be allowed to pass. At the present time railroads owe much to Mr. Vaughan for his courageous adoption of superheating on so large a scale, because it is only through large scale experiments that the information so greatly needed in matters of this kind can be secured.

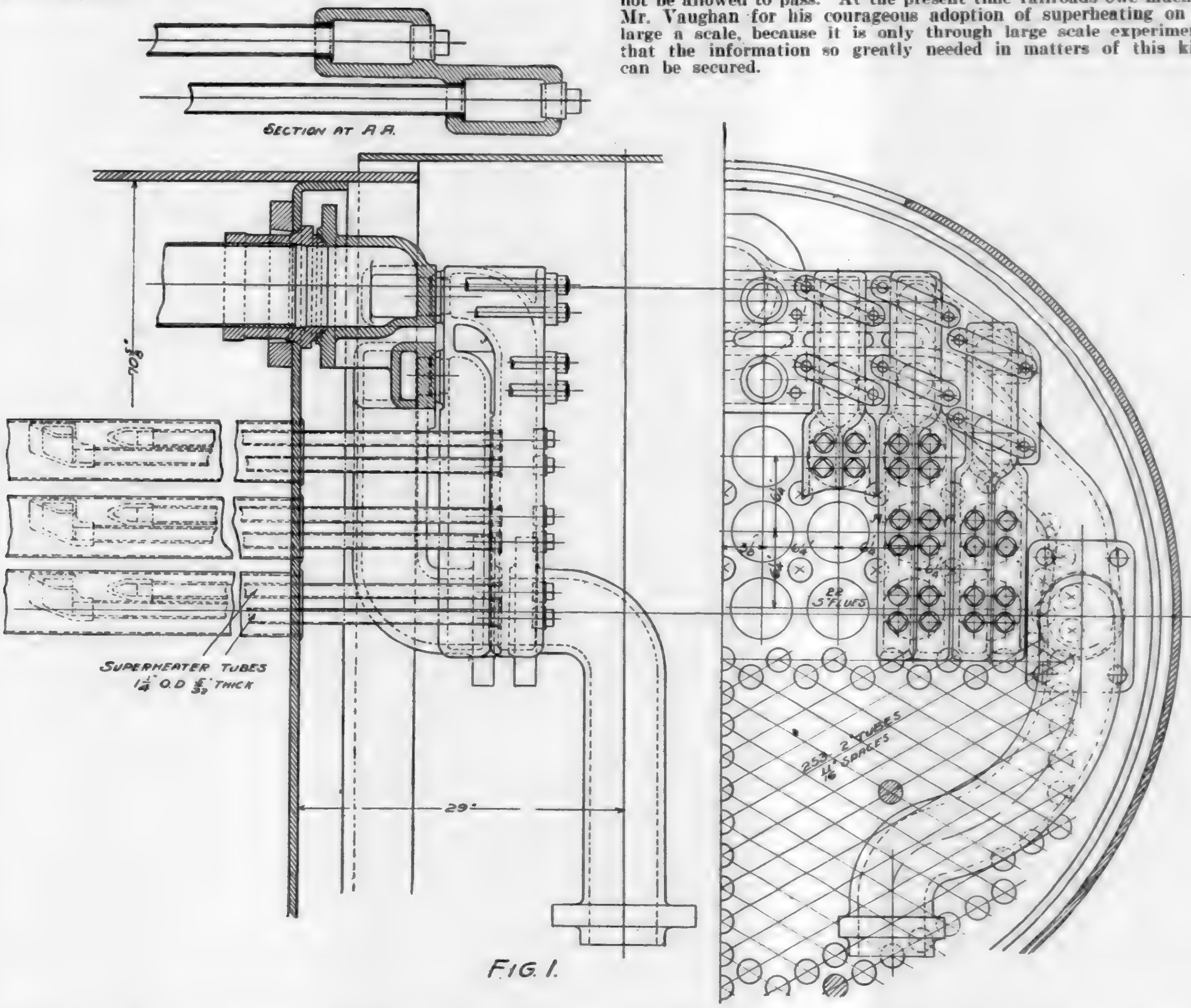


FIG. 1.

The amount of superheat obtained was measured by high-grade thermometers, with bulbs immersed in heavy oil, and the efficiency of the different systems determined by the number of B. T. Us. absorbed by the superheated steam. The original Schenectady superheater with the flow of saturated steam through the circulating tube and the superheated steam in the same direction as the flue gases, gave a figure of 39 to the basis of 100 for the results attained by the design shown in the illustrations. With the direction of the flow reversed, the figure obtained was 70, which would appear to indicate that a substantial gain is effected by causing the saturated steam to flow in a direction opposite to the flue gases.

On the other hand, under certain favorable conditions, in which the fuel causes no clogging up of the tubes, the original arrangement with 3-in. fire tubes has given very favorable results, an average temperature of between 105 deg. and 110 deg. at the steam chest being obtained, and the maximum temperature at times 25 deg. or 30 deg. in excess. In a test extending over many trips, carefully made to eliminate as many errors as possible, a fuel saving of 17 to 19 per cent. was effected.

A Prairie type passenger engine equipped with the later form of return bend superheater has been running on the L S. & M. S. Ry. in passenger service for several months, and while no accurate tests have been made, it is the opinion of the men in close touch with this engine that there is a saving in fuel and water of at least 15 per cent., and a substantial improvement in the running and operation of this engine. It is considered a very lively and fast engine, and is able to handle the heavy passenger trains with apparently greater ease than similar engines not so equipped.

On the Canadian Pacific Railway fifty-five ten-wheel freight engines have been equipped by the American Locomotive Com-

At the present time superheaters are in service upon or being built for the following railroads:

Canadian Pacific	186
Chicago & North-Western	2
Chicago, Rock Island & Pacific	6
Lake Shore & Michigan Southern	2
Delaware, Lackawanna & Western	1
Chicago, St. Paul, Minneapolis & Omaha	3
Michigan Central	1
Boston & Maine	1
Northern Pacific	3
	205

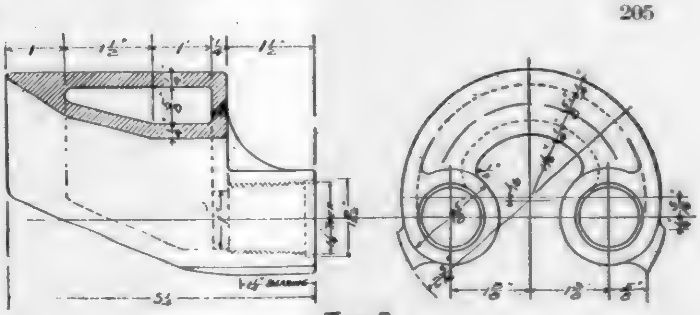


FIG. 2

and while some reports are better than others, the resultant of all the trials justifies the statement that railroads are perfectly

safe in taking into consideration this feature for new power and for renewals of old power.

In connection with superheating it is possible to reduce boiler pressure without loss of power and in further experience this may become an important factor. Thus far superheaters have been applied to existing designs and the application has, in general, been an adaptation of superheating, but the time has come for a consideration of designs prepared especially for superheating. This may or may not result in a reduction of boiler pressures, but the possibility of reducing pressures becomes important in the application of superheaters to old locomotives, the boilers of which are weakened by age and unequal to the task of maintaining high pressures. For example—by equipping an old locomotive, originally over-cylindered, with a superheater, the boiler pressure may be reduced to a reasonable extent without sacrificing power, thus adding some years to the effective life of locomotives, provided the cylinders and running gear are in condition to warrant the expenditure. This phase of superheating has not received the attention which its important merit deserves.

The attention of the writer was recently called to an operating advantage offered by the superheater which, perhaps, has not been fully appreciated. In the case referred to it is found possible for the superheater locomotive on a long passnger run to pass one of the customary coaling and watering stations without stopping. On this particular road the single application of superheating makes it exceedingly popular with operating and mechanical officials. If trains hauled by superheater locomotives are not increased in weight it may become possible to effect a material saving in certain localities from the economy thereby obtained.

Whether or not present types of superheaters prevail is not important in the present discussion. It is important for the principle of superheating to receive attention particularly from those who are now facing or are soon to face the necessity of increased capacity of locomotives with increasing weight and other limitations. From the standpoint of capacity the superheater seems to have come opportunely, because while it may be possible to increase the weight of both passenger and freight locomotives, it is desirable to have recourse to some other means for increasing capacity. As the country builds up into larger communities, traffic requirements are sure to increase, and anything which tends toward an increase of locomotive capacity should be earnestly welcomed. From the standpoint of augmented capacity, superheating is of great interest to American railroad men at the present time.

The first successful superheater applied on this continent was in 1899. At the present time 205 locomotives are equipped, or being equipped, with this device. That superheating has made such progress in so short a time is, of itself, remarkable, and it is fair to expect its satisfactory development from present experience.

Electricity on Steam Railroads.

Committee.—C. A Seley, Chairman; W. R. M'Keen, Jr., L. R. Pomeroy, C. F. Street, F. J. Cole.

The instructions of your Committee on Electricity on Steam Railroads read as follows: The committee to consider and present to the Association the relative advantages of the different systems of electric traction now in use as applied to interurban and suburban lines; also, as far as possible the relative cost of operating such lines by electricity and steam. The committee are also instructed to include in its investigations the different systems of gasoline, gasoline-electric and steam motor cars.

It is perfectly apparent that the density of traffic is the ruling factor as to whether the steam or the electric road will prove the more profitable.

It is quite well known on old established lines what the passenger returns will be with fairly steady business conditions, provided there is no change in the train accommodations, but if there is an increase in train service it is almost sure to build up an induced traffic, the amount of which is difficult to estimate. Unless, therefore, there is a reasonable basis of expectation for such traffic, the steam railway that can fully care for its own is not in need of a new system, and the expediency is doubtful.

It is believed, therefore, that where there is a sufficient density of traffic it will pay steam railroads to handle their local suburban and interurban travel electrically, giving frequent trains and frequent stops, equaling the convenience and accessibility of trolley lines, for which the public does not have to stop to consult time tables, buy tickets and go to inconvenient points to get on trains. Traffic of this kind should have its separate tracks, as it would get in the way of fast through trains and itself would be impeded by slow freight trains using the same tracks.

It would be possible to make a combination service in some territories, running slow freight though at certain hours when travel was light, or if the character of the freight would permit, to have special separate freight units which could keep out of the way of passenger traffic. As before stated, the particular class of service and the system to be used must be chosen with special reference to the situation, and these vary so that no general rule or information will apply.

It is our belief, however, that few situations will figure out profitably with the combination service, and that if electrification is warranted for passenger traffic, that a complete change will be desirable, except possibly where there is through travel involved also.

Relative Advantages of Different Systems of Electric Traction Now in Use.

By far the greater portion of present car equipments are for the use of direct current, but of late alternating current has entered the field and there are some very interesting single-phase operations, the motors employed being capable of running on either direct or alternating current, and by having suitable transformers on the cars, high line voltage may be carried, thus reducing the cost of distribution.

Long distance distribution is best accomplished by alternating current of high voltage, and if direct-current motor equipments are used the current is transformed at substations at suitable intervals and generally not over ten miles apart. These stations are equipped with transformers for stepping down the voltage, and with rotary convertors for changing the current to direct at suitable voltage for the line.

Substations on lines employing single-phase machinery have only the transformers, no rotaries being required, and this also cuts off cost of attendance except occasional inspection.

The single-phase operation is economical on account of high voltage used on the line and cheapens very much the cost of distribution from the substations, there being no difference between the power station and substations. The car equipments, however, are more expensive than direct-current apparatus, so that, assuming both to be of equal efficiency, the number of equipments and apparatus required must be considered, and their extra cost weighed as against the low cost of direct-current machinery and more expensive distribution to the line.

Gasoline, Gasoline-Electric and Steam Motor Cars.

Some time prior to the development of electric interurban railways the steam motor car or dummy, in many cases hauling a trailer, was used to a moderate extent, but at the present time few of these remain. In response to a demand from railroad managers for a motor car to operate on branch lines and special situations there has been recently a development of motor cars employing gasoline in an internal combustion engine, this engine either directly driving the car or driving a dynamo to generate current to be used for driving motors in the trucks. Some builders interpose batteries between generator and motors to store the current when it is not all needed for propulsion, and to assist in starting on grades when the generator capacity may be insufficient. There is very great flexibility and convenience in this combination, but it is attained at very considerable expense and complication, and requires unusually skilled attendance not commonly available in railroad service.

The examples of the gasoline engine, electric generator, battery and motor types are the cars of the St. Joseph Valley Traction Company's line, built by F. M. Hicks, and the Strang car (American Engineer, March, 1906, page 103), that lately made a sucful run from New York to Kansas City. The gasoline engine on these types is set to run at a constant speed, and this characteristic is essential for the best economy of the internal combustion engine. The size of the engine used may be proportioned to the average power required for normal operation, and the speed variation and excess of power above normal requirements may be supplied by the battery equipment, which also comes into play for lighting and short movements and would also be available to bring the car in in case of a breakdown of the engine or generator.

The gasoline-electric type not employing batteries is illustrated by the D. & H. car. (American Engineer, March, 1906, page 88) recently built by the General Electric Company. The generator on this type of car has to be equal to the maximum requirements, in order to vary the current for the conditions to be met, the field excitation is handled by a separate exciter, chain-driven from the main generator. The controller is semi-automatic and can be set for any predetermined maximum acceleration, and the speed of the car is governed by varying the field strength of the generator. The speed of the engine remains constant after acceleration. This application is very ingenious and effective, and we understand that the car has been put into regular service between Schenectady and Saratoga.

The Union Pacific motor car (American Engineer, May, 1906, page 187) representing the direct mechanical drive application of gasoline power, is driven by a six-cylinder reversible gasoline engine, with crank shaft at right angles to the length of car; a sprocket mounted on same, driving a special chain, transmits the power direct to the driving axle through a second sprocket attached to the axle. The chain easily shows a transmission of power with an efficiency of ninety-seven per cent., which clearly demonstrates that this method of transmission is very close to the maximum efficiency possible.

For the initial start of car, or putting it in motion, a reducing gear is used, and, until the car attains a speed of six or seven miles per hour the economy of this transmission is somewhat reduced; but, as the use of the gear is only temporary and lasts only a few seconds, it can almost be left out of consideration.

The roof of the Union Pacific motor cars is 24 inches lower than the standard height of coach roof. The car being built of steel, with pointed end and smooth exterior surface, the wind resistance is materially reduced, enabling 100 horse-power gasoline engine to drive car at the rate of sixty-five to sevently miles an hour.

The car framing is a combination of steel shapes and braces, the whole tied together by steel plates, making a unit structure, each part supporting the adjacent ones and bearing its proportion of the burden imposed upon it. These cars weigh, motor and all, twenty-six tons, which of course is a very material factor in the high speed attained by cars in service, and affords considerable economy in comparison with the heavier steam motor cars, some of which weigh seventy-five tons and over, with the same seating capacity. Motor car No 7 has seating capacity for seventy-five people, and has, in actual service, carried ninety-five.

One of the most important features in the development of the steel motor car is the reduction in height of car and consequent reduction in weight and decreased wind resistance, a result of which is the system of ventilation—taking fresh air from the front of car, delivering it at floor level and by suction, drawing the foul air out of the roof.

Motor car No. 7 is equipped with metal round sash windows—a window impervious to cold air, dust or water; in fact, is tight as a port-hole on an ocean-going vessel. These windows have demonstrated themselves to be a great luxury to the traveler.

The enclosed inside steps, with side door entrance, have also proven very popular with the traveling public. This side door entrance is permissible with steel car constrtuction without weakening same, the side sill being depressed and divided, a portion being carried over the door and the other portion under, all being tied rigidly in combination with the plate and steel sheathing of the car; forming a structure of such strength as to eliminate the usual weakness caused by a side aperture the size of door-opening in these cars.

The first cars—55 feet in length, seating capacity seventy-five and with an engine of 100 horse-power—are particularly adapted for branch line service, where the traffic is insufficient to support a steam service or anything like electric service.

Interest in the steam car is also being revived, as, for example, the Ganz cars imported from Budapest by the Florida East Coast Rys.; also the Erie R. R. and the C. P. R. R. are experimenting with a steam car equipped with a Scotch marine type of boiler, using a superheater and oil fuel. It is believed that some one may undertake to make a so-called flash boiler that will be applicable to this service.

SERVICE AND UTILITY OF MOTOR CARS.

It is recognized that the so-called motor car, one carrying its own motive power plant, whether gasoline, gasoline-electric or steam, occupies a distinct field of usefulness. Many branch lines, now existing, where travel is light, and on new extensions into unsettled country where the business will not return a profit on steam train service, would have to be run at a loss until a sufficient business was induced or built up by the travel facilities afforded. These situations are the distinct field of the motor car, which can be operated for less per car-mile than by regular steam train or electric methods until the volume of business will warrant the regular transportation methods.

The use of motor cars on the Union Pacific in picking up passengers on branch lines and in delivering passengers at connecting points for through trains is exceedingly lucrative. The matter of giving the branch line patrons of any steam road increased service, with more frequent trips per diem, is very much appreciated by the local community, and their good will is beneficial.

On the hypothesis of the same density of traffic, with the same class of service as would be encountered on one of the ordinary branch lines of the territory west of the Missouri River, the cost per mile for local train service, equipment consisting of two cars and a locomotive, would be about 24 cents, including repairs, fuel, oil, labor, cleaning, etc.; this for passenger, as well as baggage, mail and express service.

Electric service equipment, consisting of one car and trailer, figuring that the density of traffic is sufficiently regular to support same seven days in a week, is estimated at about 18 cents a mile.

The gasoline service (mechanical-drive only considered), consisting of one car and trailer, with baggage, mail and express service, would cost 15 cents per mile. The latter, of course, would be independent of whether service was six days or seven days per week, the cost simply depending upon the service rendered.

ENGINE HOUSE RUNNING REPAIR WORK ON LOCOMOTIVES.

Committee—H. T. Bentley, chairman; P. Maher, F. T. Hyndman.

The subject assigned your committee to report on is rather indefinite in so far as the latter part is concerned, for we are asked, "with what machine tools and hand tools should a roundhouse be equipped to get the best results?" If we had been told the size of the roundhouse, or the number of engines housed in a given time, we would have had something to work on; but as this information is lacking, will base our report on the assumption that it is a fifty-stall house, and that one hundred and fifty engines have to be taken care of in the twenty-four hours.

In the first place, we are asked, "What is the best practice for doing this work (running repairs on locomotives), handling reports, etc., made by foremen, engineers, road foremen and inspectors," and would say that a system as outlined below will give the maximum results with the minimum delay and expense. It is very necessary to know what work has to be done on an engine before it arrives in roundhouse, so that, if for the drop pit, it can be run there without delay, or, if any heavy repair work is necessary, it can be run into a stall convenient to machine shop, which will save time of machinists.

A system of engineers' work reports and engineers educated to report their work fully and intelligently; these slips should be deposited in a box or other receptacle, located centrally, and preferably close to the foreman's office, so that the man in charge of handling them, and distributing the work, can do so and keep in touch with the foreman.

A system of writing out the work on separate slips and giving it to the proper man, who signs same and returns it to the gang foreman when work is done, has many advocates, and enables a close check to be kept on improper repairs. Whichever system is used, it is absolutely necessary to know who has done the work, for future reference.

When an engine arrives in the roundhouse the inspector should at once make an examination of it, reporting all the work found, on the regular engineers' slip, but signing his own name and adding the word "inspector," so that a check can be kept on the engineers to see if they are looking over their engines properly.

If any repairs are necessary the gang foreman should have his men ready to make them, so as to avoid any delay; if for washing out, the steam and water should be blown off into a proper receptacle and hot water used for washing out and filling up. Great care should be exercised so that the machinists are not sent to an engine that is to be washed out, unless they can do their work without interruption. If it is necessary to grind in boiler checks, renew staybolts, or do other work that can only be done when the water is out of the boiler, advantage should be taken of this opportunity.

On some roads the road foreman of engines uses a regular blank for reporting work that he finds while riding on engines. This report should be turned in, so that it can have attention while the engine is out of service, and we recommend that work reported by a road foreman should have particular attention paid to it, as his discipline is hurt to a great extent, and his usefulness impaired, if no notice is taken of his reports.

There are so many different conditions existing in this country that it is a difficult matter to draw a hard and fast line as to how engine-house running repairs should be taken care of. On some roads the water conditions are good, so that boiler work is almost unknown. On others the amount of boiler work fixes the time an engine is out of service. On some roads, with poor coal, it is not unusual to change grates nearly every trip, while on others the coal is of such good quality that grate troubles are almost unknown. However, in all cases, the prime object of a roundhouse organization is to quickly take care of the necessary repairs, and to do so the force must be so built up that when an engine arrives in the house all concerned must know what to do and how to do it, having such tools at their command that experience teaches are most necessary.

The location of a roundhouse of the size being considered has to be taken into account. If in close proximity to the main shop, less machine tools may be necessary, but where entirely self-supporting, a proper outfit should be supplied to take care of anything that may come along.

In addition to the small tools owned and carried by the various mechanics, we recommend the following: 48 by 48 in. by 8-ft. planer, 24-in. lathe, 40-in. heavy drill press, 20-in. drill press, emery wheel, 16-in. bolt lathe, 22-in. shaper, bolt-cutter to take up to 2 ins., 36-in boring mill, hydraulic or screw plates for driving box brasses, rod bushings, etc.

Suitable cranes around engines and drop pits, either supported by posts or roof, so as to take care of air pumps, steam chests, front end doors, driving boxes and other heavy parts. The lifting on and off of cabs is something that should not be overlooked.

A driving-wheel drop pit capable of taking care of at least two engines at a time, an engine-truck drop pit capable of taking care of at least two engines at a time, a tender-truck drop pit, if trucks are suitable for wheels to be dropped.

Two gasoline or oil tire heaters, with proper-sized hoops and burners, can be used for straightening frames, etc.; a rotary valve-seat planer of sufficient size to take the largest-sized seats, a boring bar for piston valve bushings; a cylinder boring bar; 4 piston rod pullers, various sizes; 12 differential chain hoists; 4 ½-in. grab chains; 4 ⅝-in. grab chains; 12 pinch bars; 12 heavy capacity jacks, 35 or 40-ton, hydraulic or lever; 12 screw jacks for holding up work; 4 lever journal jacks; 2 lever jacks for pilot and tank work.

Two air hammers made out of pipe or old hydraulic jacks for driving out rod and frame bolts; 6 air motors, various sizes, two to be end motors for close work; 4 crosshead lifters; 2 spring pullers; 3 close chisel bars; 6 long chisel bars.

Four two-wheel trucks for moving material; 1 blacksmith forge; 1 set ratchets and rollers for valve setting; 2 four-wheel rod trucks; 1 portable arrangement for hydrostatic test.

Steam-gauge tester; complete set of drills, ¼-in. to 2-in.; small breast drill; complete set standard reamers, ¾-in. to 2-in.; pipe vise; complete set of standard taps, ¼-in. to 2-in.; cold chisels, as many as necessary.

One complete set of pipe cutters, dies and taps from ¼-in. to 3-in.; sufficient adjustable pipe wrenches to accommodate the force of men that the work requires; 6 each, open wrenches, ⅜ by ⅝ in., to 1¼ by 1¼ ins.; 2 each, large size open wrenches, up to largest size nut on locomotives; 6 mauls, various weights, 8 to 16 lbs.; 12 handle punches, ¾ to 1¼ ins.; 2 pneumatic hammers for boilermakers, chipping, etc, caulking tools, etc.; 1 complete set staybolt reamers and taps; in fact, complete outfit for staybolt, flue and grate work.

The above are about the most important factors in roundhouse work, but we would advocate sufficient chisels, gauges, hack saws, files, scrapers, straight edges, etc., to accommodate the force maintained at each roundhouse in order that one man may not be held up on a job waiting for another man to get through with some small tool.

Each roundhouse should have a separate tool room of its own, with a man in charge, both day and night, to handle the tools on a check system; otherwise, it will be impossible to maintain roundhouse tools.

In addition to above on engine-house running repairs on locomotives, the following good suggestions were brought out in discussion of this paper at the Western Railway Club meeting, held at the Auditorium Hotel, Chicago, Tuesday evening, March 20, 1906, and are endorsed by your committee.

The use of a floating or hospital gang in the roundhouse, to which gang will be turned over the heavier jobs, so as to get engines into service quickly, instead of having the work drag along with various men being put on and taken off according to the exigencies of the service; this service will often enable an engine to be kept out of the back shop and increase the mileage between shoppings.

A long master wedge for drawing piston rods into crossheads before the regular wedge is applied.

A small bolt lathe mounted on a truck and run by electric or air motor, for use around an engine where new rod, truck or cylinder bolts are being fitted, to save running back and forth to machine shop.

Always keep one engine on blocks undergoing moderately heavy repairs, so that machinists can be kept busy at all times when work in the roundhouse falls off temporarily. It is claimed that

work done in this manner costs more, but where business fluctuates it is a good proposition.

The neglect of running repairs causes engine failures to increase and also decreases the life of an engine between shoppings.

A hydraulic press operated by a screw, for forcing out rod bolts, etc., saves bolts from being upset when hit by a sledge.

An inverted "Y," with the upright leg slotted, which is used for removing heavy cylinder heads, the method of operating being to stand the "Y" against cylinder head, with feet on floor and stud through slot, the nut being put on and tightened so that when cylinder-head nuts are removed head can be "walked" away and stood ready for application.

Fire Kindling.

BY MR. P. MAHER, S. M. P., T., ST. L. & W. RY.

My recommendation would be to carry the subject over another year and place it in the hands of a committee of at least five members representing roads that use anthracite and bituminous coal, also representation from some of the Western roads using fuel oil. When we take into consideration some of the important features that govern a subject of this kind, i. e., the antiquated roundhouse with no facilities, the more modern roundhouse, equipped with hot water system and maximum air and steam pressure for blowing up locomotives, the improved smokejack, the various kinds of fuel, etc., we can readily appreciate the fact that it could be handled more intelligently by a committee than by an individual.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

Pipe Unions.—Joseph Dixon Crucible Company, Jersey City, N. J., is issuing a pamphlet which contains an article by Mr. W. H. Wakeman, on "Unions for Steam Pipes," which was first published in "Graphite." The subject is considered from an engineering standpoint and contains much matter of interest to steam users. Copies can be obtained upon request.

Friction Draft Gear.—The Republic Railway Appliance Company, St. Louis, Mo., is issuing a folder which illustrates the Republic friction draft gear by means of sectional views. A brief description of the operation and a reprint of an editorial from the *Railroad Gazette* on friction draft gears for wooden cars is also included.

Expansion Boring Tool.—The Davis Expansion Boring Tool Company, 202 South Commercial St., St. Louis, is issuing a small catalog descriptive of several different designs of boring tools, both solid and expansion. These tools have a very good record in the matter of reducing the cost of output, and are manufactured in 228 different styles and sizes for all purposes.

Piston Valves.—The American Balance Valve Company is issuing a leaflet calling attention to the new design of semi-plug piston valves recently perfected. It states that one railroad has already in service and specified on new power 1,206 of these valves. These valves are so made that they will run over ports without bridges. Booklet No. 22, issued by the company, tells all about them. It can be obtained upon request.

Machine Moulding.—Ph. Bonvillain & E. Rongeray, Paris-Aubervilliers, France, are issuing a pamphlet on the "Universal System of Machine Moulding." It contains a large amount of very interesting and instructive matter on the latest methods of moulding. It shows that machine moulding can be economically carried to a much broader field than is now generally considered possible. It is thoroughly illustrated, printed in English and can be obtained upon request.

Locomotive Coaling Station.—The Gravity Measuring Coal Chute Company, 907 Mutual Building, Richmond, Va., is issuing a catalog which is profusely illustrated with views and line drawings showing the construction and operation of its new design of gravity measuring coal chutes, which accurately measure the amount of coal taken by a locomotive by means of an auxiliary pocket without the use of scales or rehandling. This type of chute is now in successful use on several railroads, and is clearly described in this catalog, which can be obtained upon request.

Electric and Pneumatic Drills.—The Chicago Pneumatic Drill Company, Fisher Building, Chicago, is issuing special circular No. 56, which illustrates and briefly describes several different types of the air cooled Duntley electric drills for machine and car shop usage. It also shows standard types of the "Little Giant" drills, and improved "Little Giant" drills which are fitted with Corliss valves. These are claimed to be the most powerful drills ever devised for their weight. Several specialities are also shown, including a magnetic-holder-on, portable blower, portable drilling stand, etc.

Gravity Dump Cars.—E. W. Summers, Farmer's Bank Building, Pittsburgh, is issuing a small folder which shows the construction and operation of the Summers gravity dump car in a clear manner. This car has a number of special and interesting features, and is arranged to discharge its load by gravity on either side, both sides, or in the center of the track, the construction being such that the discharge is controlled by cranks at the end of the car. These cranks are so connected to the doors that when they are released the door is automatically locked at that point. The folder shows cross sections of the car in operation under different service conditions. Copies can be obtained upon request.

Car Wheel Lathes.—Progress Reporter No. 31, published by the Niles-Bement-Pond Company, illustrates and describes special machines for turning steel tired car wheels. This issue supersedes No. 4, published in September, 1904, on the same subject, which during the past two years has seen so large an improvement as to make the former methods recommended out of date. The present issue shows a large number of illustrations of machines and appliances for handling and turning the wheels, and includes much valuable information in connection with the work. Dimension drawings of proper tools for turning car wheels are included.

Variable Speed Motors.—The Northern Electrical Manufacturing Company, Madison, Wis., is issuing a catalog describing the Northern single voltage variable speed motors. Complete descriptive matter of the motor and its operation, as well as a large number of illustrations, showing its application to many different types of machine tools are included. In brief the system used obtains speed variation by the insertion of resistance in a shunt field. The special design adopted allows variations of 200 to 300 per cent. in speed with economical operation at all points. These motors use but one commutator and are of very simple and light construction. The catalog also considers the proper controlling apparatus for different drives.

Blue Print Machine.—The Revolute Machine Company, 523 West 45th St., New York, has recently perfected a blue print machine of special merit. This machine consists of a rotating glass cylinder, which lies in a series of narrow belts, and within this cylinder are placed two mercury vapor electric lamps. The roll of paper to be printed is placed in a box on top of the machine, and feeds in continuously between the belts and the cylinder. The tracings are inserted between the paper and the cylinder, and after passing around ¾ of the circumference of the cylinder are deposited with the paper in a box in the front part of the machine. Very high speed is claimed for this apparatus as well as especially sharp, clear prints. Its features are clearly shown in a small folder, which can be obtained upon request.

Locomotive Valve Gear.—The Locomotive Appliance Company, Old Colony Building, Chicago, is issuing an attractive catalog descriptive of its latest design of valve gear for locomotives. This gear is clearly shown by line drawings and photographic reproductions of the different parts and its operation is clearly explained in the type matter and illustrated by the reproduction of actual indicator cards. This latest design of Alfree-Hubbell valve gear is all contained within the cylinder casting, the valve stem connecting to the regular rocker arm of the locomotive without the use of gears or other attachments outside the steam chest. It has been in service on several roads for some time with much success. A substantial increase in the tonnage of the locomotive equipped with this valve gear, it is claimed, has been attained in all instances. Copies of the catalog can be obtained upon request.

Electric Apparatus.—The General Electric Company is issuing a very attractive catalog, describing and illustrating different types of electric radiators. These in many cases are portable and illustrations are given, showing their application for resident and office use. They are made in luminous and non-luminous types. The same company is issuing a number of bulletins, one of which illustrates and describes a 25 k.w. Curtis steam turbine generator set. It is designed to take the place of small direct or belt connected engine driven sets. Another illustrates and describes panels for two and three-phase alternating induction motors, being designed for individual installation and not intended to form part of the main switchboard. The third bullettin describes, by means of illustrations, curves and complete written matter the type

GEA 605A railway motors. This is a single-phase motor rated at 75 h.-p., and is specially recommended for interurban work.

ELECTRIC MOTORS AND TRANSFORMERS.—The Crocker-Wheeler Company, Ampere, N. J., has issued bulletins Nos. 64 and 65, the former of which thoroughly illustrates and carefully describes form I. electric motors, which are made in sizes of 3 to 45 h.-p. Also similar generators in sizes from 2½ to 40 k.w. A number of illustrations showing these motors applied to different machine tools and a description of the application are included. Bulletin No. 65 illustrates and describes in detail core type transformers for high tension power work. These transformers have received a large amount of favorable mention by their users. The same company is also issuing a pamphlet on its system of electric motor control which uses a three-unit balancer and obtains six different voltages. Diagrams of the different controller connections for different speeds of motors are given. This system of motor control is in successful operation in many large plants.

ELECTRIC MOTOR AND TRAILER TRUCKS.—A pamphlet describing electric motor and trailer trucks has just been issued by the American Locomotive Company illustrating the types of this equipment, designed and built by them. The pamphlet begins with a description of the principles of the designs, of which fifteen are illustrated by full-page drawings. The designs illustrated include motor trucks for the New York Central suburban service, for the Paris-Orleans, the Schenectady, the Delaware & Hudson, the Brooklyn Rapid Transit, the Buffalo & Lockport and other railways. The drawings show the construction in detail, rendering it an easy matter to study the designs. In addition to the drawings, nearly all of the trucks are illustrated by reproductions from photographs. Among the details illustrated are cast steel and wrought iron bolsters, truck hangers, spring planks, Brinkerhoff-Doyle wheel hubs and journal boxes with collarless and collar axles. Copies of the pamphlet will be supplied upon request to the American Locomotive Company.

PNEUMATIC APPARATUS.—The Ingersoll-Rand Company, 11 Broadway, New York, is issuing several new catalogs and bulletins, describing pneumatic tools, air compressors, rock drills, etc. One of these is given up completely to the description of the Imperial piston drills, which are shown in several different forms and sizes. A number of illustrations showing these drills in operation under railroad shop conditions are included, and a list and table of parts for each type are also given. Another catalog thoroughly describes and illustrates the Imperial power driven air compressor. This machine is shown in several different forms and sizes, driven by belt, chain or gear, in single and duplex acting designs. Much matter of interest to compressed air users will be found in this catalog. A third catalog considers rock drills and mountings. Complete illustrations and descriptive matter of pneumatic rock drills and appliances are given therein. A small booklet entitled "Pneumatic Tools" briefly considers a few of the more important designs of Imperial riveting and chipping hammers, Haeseler Imperial drills, yoke riveters, rivet forges, etc.

BLOWERS, FANS AND ENGINES.—The American Blower Company, Detroit, is issuing several new catalogs and leaflets descriptive of different blowing apparatus; one of these deals exclusively with disc ventilating fans, and describes, by means of illustrations and type matter, several different designs of these fans. The important details are given careful attention. Another catalog deals exclusively with steel plate fans, which are treated in a similar manner, illustrations of parts and details being included. A third catalog deals with the blower complete as used for heating, ventilating and drying. These are shown either as direct-driven or belted from shaft or engine. Several interesting applications of direct-connected electric motors are included. Another catalog shows many of the interesting and important details of the enclosed high-speed, self-oiling blowing engines furnished by this company. A small booklet is also being sent out which briefly illustrates and describes several different designs of heating coils for dry kilns. Any of these catalogs can be obtained upon request.

LOCOMOTIVE TESTS—PENNSYLVANIA RAILROAD.—A compilation by Dr. W. F. M. Goss from the recent publication by the Pennsylvania Railroad, describing the locomotive tests and exhibits of that road at the Louisiana Purchase Exhibition, has been issued by the American Locomotive Company. This pamphlet presents, in concise form, an account of the locomotive tests at St. Louis, giving specific information concerning each of the locomotives tested, and presenting the results separately for each of the eight locomotives. In the pamphlet four pages are devoted to a description of each locomotive and a discussion of its performance, including a summary of the data of the tests. This is followed by comparisons and conclusions compiled by Dr. Goss from the very elaborate record of the tests recently issued in book form by the Pennsylvania Railroad. While the pamphlet does not add to the information given in the book, it presents the conclusions and comparisons in form for convenient reference. This pamphlet will give a very wide distribution to a summary of the important records of the testing plant at St. Louis. For a more complete record the book published by the Pennsylvania Railroad may be consulted, than which there is nothing more valuable in recent literature of the locomotive. Copies of the pamphlet may be had from the American Locomotive Company.

NOTES.

THE QUINCY, MANCHESTER, SARGENT COMPANY.—This company announces that Mr. James L. Pilling is no longer in any way connected with it.

STURTEVANT HEATERS.—The new locomotive shops of the Missouri, Kansas & Texas R. R., Parsons, Kansas, are being equipped with a complete heating and ventilating system, installed by the B. F. Sturtevant Co.

BUDA FOUNDRY BRANCH IN ST. LOUIS.—The Buda Foundry & Manufacturing Company of Chicago has opened a branch house in the Frisco Building, and also established a warehouse in St. Louis. The new branch will be in charge of Mr. W. E. Marvel.

DAYTON PNEUMATIC TOOL CO.—David O. Holbrook, who until recently was Vice-President of the Pennsylvania Malleable Company and the Central Car Wheel Company, has been elected Vice-President of the Dayton Pneumatic Tool Company, Pittsburg, Pa., and has opened an office for the Company at No. 717 Park Building, Pittsburg, Pa.

CROCKER-WHEELER CO.—Dr. Schuyler Skaats Wheeler, president of the Crocker-Wheeler Company, Ampere, N. J., sailed June 14, on the Lloyd steamship "Barbarossa," for a short European trip. He was accompanied by Prof. Francis B. Crocker, Professor of Electrical Engineering at Columbia University, who has been associated with him in business for many years

GENERAL ELECTRIC OFFICE AT SAN FRANCISCO.—The General Electric Company which established its main office in the Union Savings Bank Building at Oakland, California, immediately after the San Francisco disaster, as well as a local office at No. 1759 Geary Street, in the burned city, has leased a suite of rooms in the new Monadnock Building, which they expect to occupy about June 15, 1907. For handling the present business, a half a block of land has been leased in Emeryville, and a temporary building is now about completed for taking care of stock, and work has already been started on a new warehouse, which will be located at the south end of the block, bounded by Kansas, Rhode Island, 15th and Alameda Streets.

NORTON COMPANY.—The Norton Emery Wheel Company, Worcester, Mass., has just been granted permission by the state legislature to change its name to Norton Company. For a considerable period this company has been making its grinding wheels of alundum, an artificial abrasive, in place of emery. The Norton Company has a plant at Niagara Falls, N. Y., which manufactures alundum exclusively for the use of the Worcester works, and during the past year it has been found necessary to double its size. The process of making alundum consists in taking the purest amorphous oxide of aluminum found in nature, known as the mineral bauxite, purifying it and melting it in an electric furnace in a large, homogeneous uniform bath. Upon cooling, this molten fluid solidifies and crystallizes in solid masses of alundum of great purity and absolute uniformity throughout, and of a hardness greater than any known substance except the diamond. The process is patented both at home and abroad, and was awarded the grand prize at the Louisiana Purchase Exposition.

THE ARMSTRONG MFG. COMPANY.—This company of Bridgeport, Conn., has opened a branch office and warerooms at 23 South Canal Street, Chicago, Ill. The new branch is in charge of Mr. Hugh S. Laing, formerly assistant manager of the New York City branch. A full stock will be maintained in the warerooms to enable customers in the district to receive their orders promptly.

VENTILATING THE GALLITZIN TUNNEL.—After the completion of the Gallitzin Tunnel on the Pennsylvania Railroad it was found that great difficulty was experienced on account of the smoke and gases discharged by locomotives. These caused the atmosphere to become so bad as to seriously interfere with the work of the trainmen, and it was necessary to provide relief. This was done by constructing at the east end a ventilating apparatus, consisting of a sheet iron hood about 50 ft. long, enclosing one track and having an inner surface coincident with the soffit of the tunnel arch and walls. The outer surface converged from the outer end of the hood to the portal of the tunnel so as to give it a wedge-shaped cross-section. A Sturtevant blower was installed at the end of the hood on each side and delivered air through it to the tunnel portal, where a narrow opening in the inner surface of the hood permitted the blast to be forced into the tunnel nearly parallel with its axis. Trains pass through this tunnel in one direction only, and as the grade is up from this end they are usually drawn by two locomotives in front and one pusher behind. As soon as the forward locomotive enters the tunnel the fan is started. The large volume of air which is forced into the narrow space between the train and the tunnel lining drives the smoke and gas in advance of the locomotive, so that its engineer can keep the cab windows open and is supplied with an abundance of fresh pure air. The second locomotive does not work in the tunnel, and the smoke from the pusher never reaches the front of the train. This arrangement is considered efficient and satisfactory.

CONVENTION EXHIBITS.

The exhibits except for the large Niles-Bement-Pond driving wheel lathe and the track exhibits were on the Steel Pier. There were 244 exhibitors with a total floor space of 65,235 sq. ft., as against 208 exhibitors with a floor space of 38,123 sq. ft. at Manhattan Beach last year. Among the exhibitors were the following:

Acme Ball Bearing Company, Chappaqua, N. Y.
Adams & Westlake Company, Chicago, Ill.
Adreon & Company, St. Louis, Mo.
Ajax Metal Company, The, Phila., Pa.
American Balance Valve Company, Jersey Shore, Pa.
American Brake Shoe & Foundry Company, Mahwah, N. J.
American Car & Foundry Company, New York.
American File & Sharpener Company, New York.
American Lock Nut Company, Boston, Mass.
American Locomotive Company, New York.
American Mason Safety Tread Company, Boston, Mass.
American Palace Car Company, New York.
American Steam Gauge & Valve Mfg. Company, Boston, Mass.
American Steel Foundries Company, Chicago, Ill.
American Water Softener Company, Phila., Pa.
Armstrong Bros. Tool Company, Chicago, Ill.
Asbestos Slate & Sheathing Company, Ambler, Pa.
Ashton Valve Company, Boston, Mass.
Baeder, Adamson & Company, Phila., Pa.
Baker Heating & Supply Company, New York.
Baldwin Locomotive Works, Phila., Pa.
Baldwin Steel Company, New York.
Barnett Equipment Company, Newark, N. J.
Besley, Chas. H. & Company, Chicago, Ill.
Bettendorf Axle Company, Davenport, Ia.
Bliss Electric Car Lighting Company, Milwaukee, Wis.
Boker & Company, Herman, New York.
Bordo, L. J., Company, Phila., Pa.
Bowser, S. F., & Company, Fort Wayne, Ind.
Bradford Draft Gear Company, Chicago, Ill.
Brady Brass Company, Jersey City, N. J.
Brown Hoisting Machine Company, Cleveland, O.
Buckeye Steel Castings Company, Columbus, O.
Buffalo Brake Beam Company, Buffalo, N. Y.
Butler Draw-bar Attachment Company, Cleveland, O.
Camel Company, Chicago, Ill.
Carey, Phillip Mfg. Company, Lockland, Cincinnati, O.
Chicago Car Heating Company, Chicago, Ill.
Chicago Pneumatic Tool Company, Chicago, Ill.
Cleveland Car Specialty Company, Cleveland, O.
Cleveland Pneumatic Tool Company, Cleveland, O.
Columbus Pneumatic Tool Company, Columbus, O.
Consolidated Car Heating Company, Albany, N. Y.
Consolidated Railway Electric Lighting & Equipment Company, New York.
Crocker-Wheeler Company, Ampere, N. J.
Crosby Steam Gage & Valve Mfg. Company, Boston, Mass.
Davis, John, Company, Chicago, Ill.
Davis Expansion Boring Tool Company, St. Louis, Mo.
Davis Pressed Steel Company, Wilmington, Del.
Dearborn Drug & Chemical Works, Chicago, Ill.
Dearborn Paint Company, Chicago, Ill.
Detroit Lubricator Company, Detroit, Mich.
Diamond Machine Company, Providence, R. I.
Dickinson, Paul, Chicago, Ill.
Dill, T. C., Machine Company, Phila., Pa.
Dixon Crucible Company, Joseph, Jersey City, N. J.
Drouve Company, The G., Bridgeport, Conn.
Duff Manufacturing Company, Pittsburgh, Pa.
Duner Company, Chicago, Ill.
Edwards Company, The O. M., Syracuse, N. Y.
Electric Storage Battery Company, Phila., Pa.
Fairbanks, Morse & Company, Chicago, Ill.
Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio.
Farlow Draft Gear Company, Baltimore, Md.
Flannery Bolt Company, Pittsburgh, Pa.
Franklin Railway Supply Company, Franklin, Pa.
Frost Railway Supply Company, Detroit, Mich.
Galena-Signal Oil Company, Franklin, Pa.
Garlock Packing Company, Palmyra, Pa.
General Electric Company, Schenectady, N. Y.
Gold Car Heating & Lighting Company, New York.
Gould Coupler Company, New York.
Gould Storage Battery Company, New York.
Green, Tweed & Company, New York.
Hale & Kilburn Manufacturing Company, Phila., Pa.
Hammet, H. G., Troy, N. Y.
Hanlon Locomotive Sander Company, Winchester, Mass.
Harrison Dust Guard Company, Toledo, O.
Heath & Milligan Mfg. Company, Chicago, Ill.
Holcomb Steel Company, Syracuse, N. Y.
Homestead Valve Mfg. Company, Pittsburgh, Pa.
Hunt-Spiller Mfg. Corporation, Boston, Mass.
Independent Pneumatic Tool Company, Chicago, Ill.
Ingersoll-Rand Company, New York.
International Correspondence Schools, Scranton, Pa.
Invincible Roll Screen Company, Brooklyn, N. Y.
Jenkins Brothers, New York.
Justice Company, Phillip S., Phila., Pa.
Kalamazoo Railway Supply Company, Kalamazoo, Mich.
Kennicott Water Softener Company, Chicago.
Landis Machine Company, Waynesboro, Pa.
Landis Tool Company, Waynesboro, Pa.
Latrobe Steel & Coupler Company, Chicago, Ill.
Lincoln Electric Mfg. Co., Cleveland, O.
Lord Company, G. W., Phila., Pa.
McConway & Torley Company, Pittsburgh, Pa.
McCord & Company, Chicago.
McGuire-Cummings Mfg. Company, Chicago, Ill.
Manning, Maxwell & Moore, New York.
Merritt & Company, Phila., Pa.
Michigan Lubricator Company, Detroit, Mich.
Moran Flexible Joint Company, Louisville, Ky.
Morse Twist Drill & Machine Company, New Bedford, Mass.
Nathan Mfg. Company, New York.
National Car Coupler Company, Chicago, Ill.
National Malleable Castings Company, Cleveland, O.
New Jersey Tube Company, Newark, N. J.
New York Air Brake Company, New York.
Niles-Bement-Pond Company, New York.
Norton Emery Wheel Company, Worcester, Mass.
Norton Grinding Machine Company, Worcester, Mass.
Oliver Machinery Company, Grand Rapids, Mich.
Penn Steel Casting & Machine Company, Chester, Pa.
Pennsylvania Rubber Company, Jeanette, Pa.
Pittsburg Steel Company, Pittsburgh, Pa.
Pressed Steel Car Company, New York.
Quincy, Manchester, Sargent Company, Chicago, Ill.
Ralston Steel Car Company, Columbus, O.
Republic Railway Appliance Company, St. Louis, Mo.
Riverside Metal Company, Riverside, N. J.
Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.
Ryerson & Son, Jos. T., Chicago, Ill.
Safety Car Heating & Lighting Company, New York.
Schoen Steel Wheel Company, Pittsburgh, Pa.
Sellers & Company, William, Phila., Pa.
Shelby Steel Tube Company, Pittsburgh, Pa.
Sight-Feed Oil Pump Company, Milwaukee, Wis.
Sprague Electric Company, New York.
Standard Coupler Company, New York.
Standard Steel Works, Phila., Pa.
Star Brass Mfg. Company, Boston, Mass.
Stoever Foundry & Mfg. Company, Myerstown, Pa.
Symington, The T. H., Company, Baltimore, Md.
Talmage Mfg. Company, Cleveland, O.
Thompson, C. A., St. Louis, Mo.
Tyler Tube & Pipe Company, New York.
United States Lighting & Heating Company, New York.
United States Metal & Mfg. Company, New York.
Vacuum Cleaner Company, New York.
Wellman & Street, Pittsburgh, Pa.
Western Railway Equipment Company, St. Louis, Mo.
Westinghouse Air Brake Company, Pittsburgh, Pa.
Whitney Mfg. Company, Hartford, Conn.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL
AUGUST, 1906.

FOUR CYLINDER BALANCE SIMPLE LOCOMOTIVE.

LAKE SHORE AND MICHIGAN SOUTHERN RAILWAY.

The first four-cylinder balanced simple locomotive to be built in this country was recently finished at the Collinwood shops of the Lake Shore & Michigan Southern Railway, and has been put into service. It is an inspection engine, where the easy riding features of a balanced locomotive are particularly desirable, and was constructed after designs prepared by Mr. H. F. Ball, superintendent of motive power, and Mr. R. B. Kendig, mechanical engineer.

As can be seen in the illustration, it is of the American type with the forward or main drivers set over 13 ft. from the centre of the cylinder. There are four equal cylinders each 12½ by 20 ins. set in a horizontal line below the front end. The two outside cylinders are connected to the drivers in the usual manner and the inside cylinders drive through practically duplicate connections to the crank axle. A single piston valve with inside admission is located between and above the cylinders and is operated by a simple design of Walschaert valve gear.

The boiler is surmounted by a large observation cab which extends from just behind the smoke stack back to and including the regular locomotive cab. The design of this cab is similar to a coach body with the regularly spaced windows and a typical coach roof. The observation room proper is 13 ft. 9½ ins. long and includes four windows on either side. Provision is made for placing four easy chairs on either side of the boiler, and there is additional room provided by a permanent seat on top of the boiler barrel at the rear wall of the observation room and by the flat section on top of the boiler, which can be used either as a seat or for chairs. The floor of the cab is raised from 6 to 12 ins. above the running board, the rear half being 6 ins. above that ahead. The heating coils are placed on either side of the boiler in the narrow runway just above the floor level, the sides of this space facing the cab are of grating and the top forms a step or foot rest. The boiler barrel is heavily lagged as is also the under section of the covering forming the seat and sides over the boiler. There is also a dead air space between the two which further insulates the cab. The windows are arranged with a balanced hanging so that they can be dropped down into the sides of the car, the sill piece being so constructed as to slide over the opening, making a smooth sill when the windows are opened and preventing rattling when closed. The front doors open to the winding steps leading forward and are arranged to swing outward so that the pressure of air while the locomotive is running tends to hold them tightly closed. An adjustable rod is provided for holding them open at any desired amount. An auxilliary engineers' valve and a system of signals to the engineer are located convenient to the front right hand chair. The interior of the cab is finished in the same excellent style seen in modern passenger coaches.

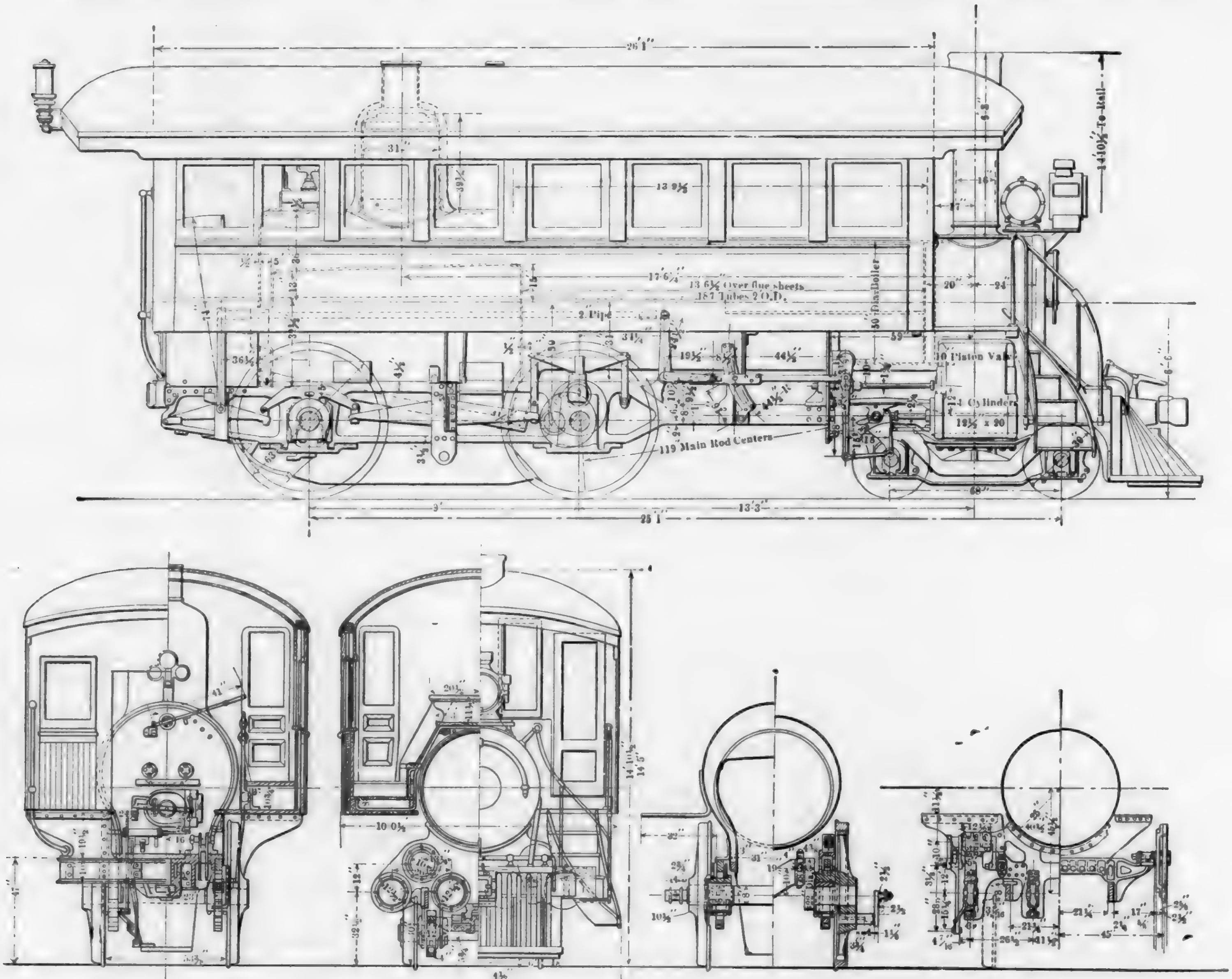
A standard type of tender is used, having in addition a covering which completely closes over the coal space, thus preventing the blowing of the coal dust to the cars in the rear. This is a sheet iron covering arranged with two large hinged doors which can be swung back for filling the tender.

The point of greatest interest in this locomotive is found in the design of the cylinders and valve, detail drawings of which are shown herewith. The operation of two simple cylinders connected at 180 degs. with each other by a single piston valve introduces some new problems into the cylinder design, which it can be seen have been solved in a very straightforward manner. The valve chamber has but two steam ports, each of which is connected to opposite ends of the two cylinders on that side by passages which are of ample area and are comparatively unrestricted. This permits the use of the same type of piston valve and bushing as would be used with a simple engine, since an opening in the port allows the steam to enter the rear of one cylinder and the forward end of the other at the same time and in equal amounts, thus giving each piston equal pressure and maintaining the balance. The combined area of these two 12½ in. cylinders is about equal to the area of a single 17¾ in. cylinder, from which it can be seen that the port opening necessary to supply the proper volume of steam through a 10 in. piston valve would not be any greater than would be necessary on a simple engine, thus allowing the design of the valve gear as well as its setting to be undertaken in the same manner as if the engine had simply the outside cylinders in operation.

The valve gear, as mentioned above, is of the Walschaert type and operates the valve stem through a cross head connection, the cross head, however, being on the rocker arm and working in a yoke on the valve stem.

In other respects this locomotive is of the usual design for a small narrow fire box American type engine. Its weights and general dimensions are given in the table below.

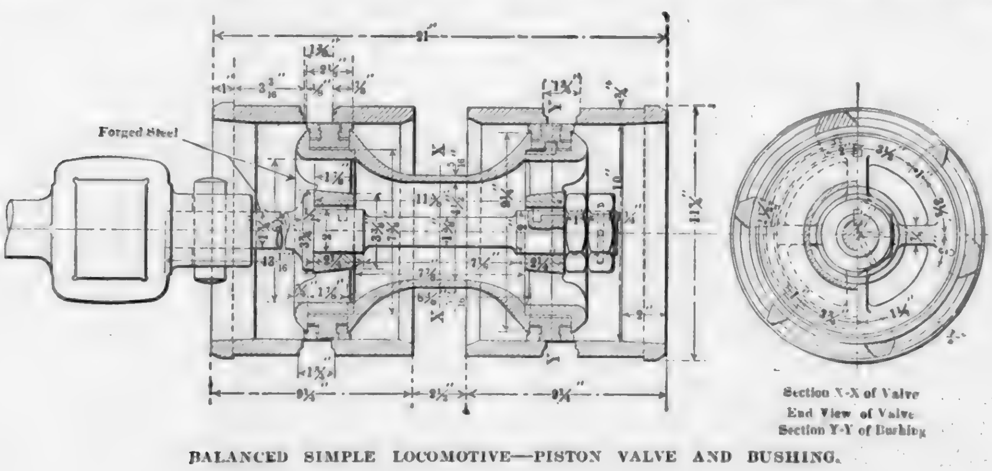
FOUR CYLINDER BALANCED SIMPLE INSPECTION LOCOMOTIVE, LAKE SHORE AND MICHIGAN SOUTHERN RAILWAY.



ELEVATION AND SECTIONS OF FOUR CYLINDER BALANCED SIMPLE LOCOMOTIVE—L. S. & M. S. RY.

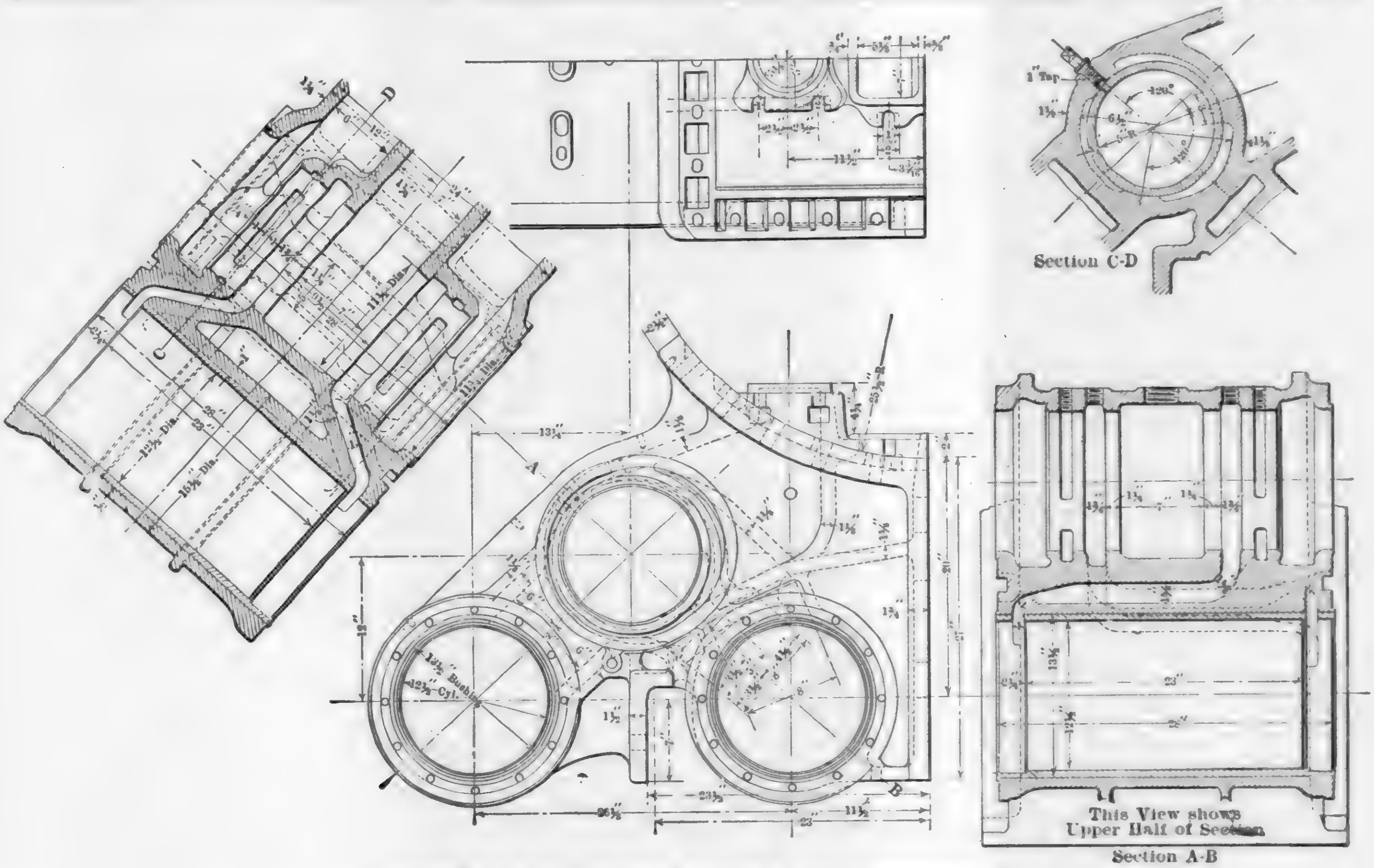
On page 217 of our June issue we illustrated a four-cylinder balanced simple passenger locomotive built for the Belgium State Railways, which was an example of the methods used abroad for accomplishing the combination of the highly desirable balanced feature with a simple engine. That engine, however, was designed for regular high speed passenger service and can be compared with this American example only in a general way, since the service of the two engines is entirely different. However, a comparison of the two designs affords a number of points of interest and does not by any means result to the disadvantage of the American engine. The most noticeable feature of difference is found in the use of but one valve on the Lake Shore engine where two are used on the Belgium engine. This results in a very decided simplification of the machinery in connection with the cylinders, all of which is subject to wear and is a source of expense, and while the use of a single valve may be considered to complicate the cylinder casting somewhat, we believe that it is an improvement and that future American designs of this type of engine will use the single valve until the cylinders reach such a size as to make a single valve chamber unwieldy.

In the matter of superheated steam as used on the Belgium engine it is by all means desirable where the locomotive is to be operated in heavy service. Its special properties of being a poor heat conductor and of rapid movement are specially desirable with this type of locomotive and will aid largely in keeping down the size of the single valve chamber for the two cylinders, as well as largely prevent the condensation losses necessarily accom-



Section X-X of Valve
End View of Valve
Section Y-Y of Bushing

BALANCED SIMPLE LOCOMOTIVE—PISTON VALVE AND BUSHING.



CYLINDERS FOR FOUR CYLINDER BALANCED SIMPLE LOCOMOTIVE.

panying the increased area of passages and cylinder walls.

The general dimensions are as follows:

FOUR CYLINDER BALANCED SIMPLE INSPECTION LOCOMOTIVE.
LAKE SHORE & MICHIGAN SOUTHERN RY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Inspection
Fuel	Bituminous coal
Tractive power	15,700 lbs.
Weight in working order	126,600
Weight on drivers	85,100
Weight on truck	41,500
Wheel base, driving	9 ft.
Wheel base, total	25 ft. 1 in.
Wheel base, engine and tender	48 ft. 4¾ ins.

RATIOS.

Weight on drivers ÷ tractive effort	5.4
Total weight ÷ tractive effort	8.1
Tractive effort x diam. drivers ÷ heating surface	670
Total heating surface ÷ grate area	69.5
Firebox heating surface ÷ total heating surface	9.5 %
Weight on drivers ÷ total heating surface	58
Total weight ÷ total heating surface	86.5
Volume four cylinders	5.7 cu. ft.
Total heating surface ÷ vol. cylinders	258
Grate area ÷ vol. cylinders	3.7

CYLINDERS.

Number	4
Kind	Simple
Diameter and stroke	12½ x 20 ins.

VALVES.

Kind	Piston
Diameter	10 ins.
Greatest travel	4¾ ins.
Outside lap	⅞ in.
Inside clearance	⅞ in.
Lead in full gear	⅛ in.

WHEELS.

Driving, diameter over tires	63 ins.
Driving, thickness of tires	3½ ins.
Driving journals, diameter and length	8¼ x 10 ins.
Engine truck wheels, diameter	30 ins.
Engine truck, journals	6 x 12 ins.

BOILER.

Style	Wagon top
Working pressure	180 lbs.
Outside diameter of first ring	50 ins.
Firebox, length and width	96 x 31 ins.
Firebox plates, thickness	⅜ ins.
Firebox, water space	F. 4½, B. 4, S3 ins.
Tubes, number and outside diameter	187 ft 2 ins.
Tubes, length	13 ft. 6½ ins.
Heating surface, tubes	1,326 sq. ft.
Heating surface, firebox	140 sq. ft.
Heating surface, total	1,466 sq. ft.
Grate area	21 sq. ft.
Smokestack, diameter	16 ins.
Smokestack, height above rail	14 ft. 10½ ins.
Centre of boiler above rail	6 ft. 6 ins.

TENDER.

Frame	10 in. channel
Wheels, diameter	33 ins.
Journals, diameter and length	5 x 9 ins.
Water capacity	4,300 gals.
Coal capacity	10 tons

EFFICIENCY AND ECONOMY OF THE LOCOMOTIVE.—As yet, comparatively little has been done in the improvement of the locomotive in this country in the direction of superior economy and efficiency. In Europe the high price of coal has led to care in design and in operation of locomotives which is unknown here. The French are a generation in advance of us in locomotive operation. In France, locomotive engineers use devices such as double valve gears and variable exhaust nozzles, which we do not intrust to our engineers and firemen. In England, the small number of locomotive failures on the road is a revelation to any one who studies them from our standpoint. In England the locomotive is given a fair chance by receiving fair treatment, yet it probably does not cost more in the end. We certainly have much to learn from across the water, and while what we may learn is not so much in practice as in method, it is none the less important. That which we most need to learn from England is the value of appreciation of the locomotive and locomotive men.—*Mr. G. M. Basford, at Purdue University.*

Mr. T. Roope has resigned as superintendent of motive power of the Chicago, Rock Island Island & Pacific Ry. at Topeka, Kan., to accept the position of superintendent of motive power of the Chicago, Burlington & Quincy Ry. lines west of the Missouri River, with headquarters at Lincoln, Neb., succeeding Mr. R. D. Smith, resigned.

Mr. D. R. MacBain, heretofore division master mechanic of the Michigan Central R. R., at Jackson, Mich., has been appointed assistant superintendent of motive power, with headquarters at that point.

Mr. George E. Parks, mechanical engineer of the Michigan Central R. R., with office at Detroit, Mich., has been appointed division master mechanic of the same road, at Jackson, Mich.

STEAM MOTOR CAR—CANADIAN PACIFIC RY.

STEAM MOTOR CAR.

CANADIAN PACIFIC RAILWAY.

Experience with independently operated motor cars on steam railroads in this country has been confined largely to those operated by either gasoline engine direct or through the medium of an electric current from a dynamo driven by a gasoline engine located on the car, and several cars of both of these types have been illustated in this journal. The experience with motor cars on steam railroads in England and on the Continent has been, on the other hand, more extensive with cars driven by steam, and a number of successful designs have been in quite extensive service for a sufficient length of time to show that they can handle the traffic on certain branch and interurban lines with satisfaction and economy.

This successful foreign experience with steam-driven cars supplemented by several other reasons, such as the greater familiarity of trainmen with steam operation, the more satisfactory and convenient control as compared with direct-driven gasoline cars, the present greater reliability, and in some cases the cheaper operation, has led several American railroads to recently begin experimenting with this type, using in some cases cars purchased from special manufacturers, and in others cars designed and built at their own shops.

In this latter class is a steam motor car which has been in operation for some time on the Canadian Pacific Railway out of Montreal. This car was designed in the mechanical department of the road under the direction of Mr. H. H. Vaughan, assistant to the vice-president, and Mr. A. W. Horsey, mechanical engineer, and consists, when reduced to its elements, of a four-wheeled, single driver locomotive, which forms one truck of and is incorporated in the car body of a combination passenger coach. As can be seen in the illustration, an extra long body with a blind end ahead is used, which is divided into three compartments, the forward one containing the boiler and the engine control apparatus, the second being a small baggage compartment and the remainder a passenger compartment, with a platform and entrance at the rear.

The locomotive or steam motor part of the car is supported on a 4-wheel truck, the forward pair of wheels forming the drivers, and the others being trailing wheels. The truck frame is made up of ⅞-in. steel plates in a very strong and substantial manner, and the cylinders are located in the rear, being supported on an extension from the frame. The cylinders are 10 by 15 ins., and have inside admission piston valves, which are operated through a simple design of Walschaert valve gear. The illustration shows the construction and arrangement at this point very clearly. The driving wheels, which have cast steel centers, are 42 ins. in diameter, and the trailing wheels are 34 ins. in diameter. All journals are 8 by 12 on this truck.

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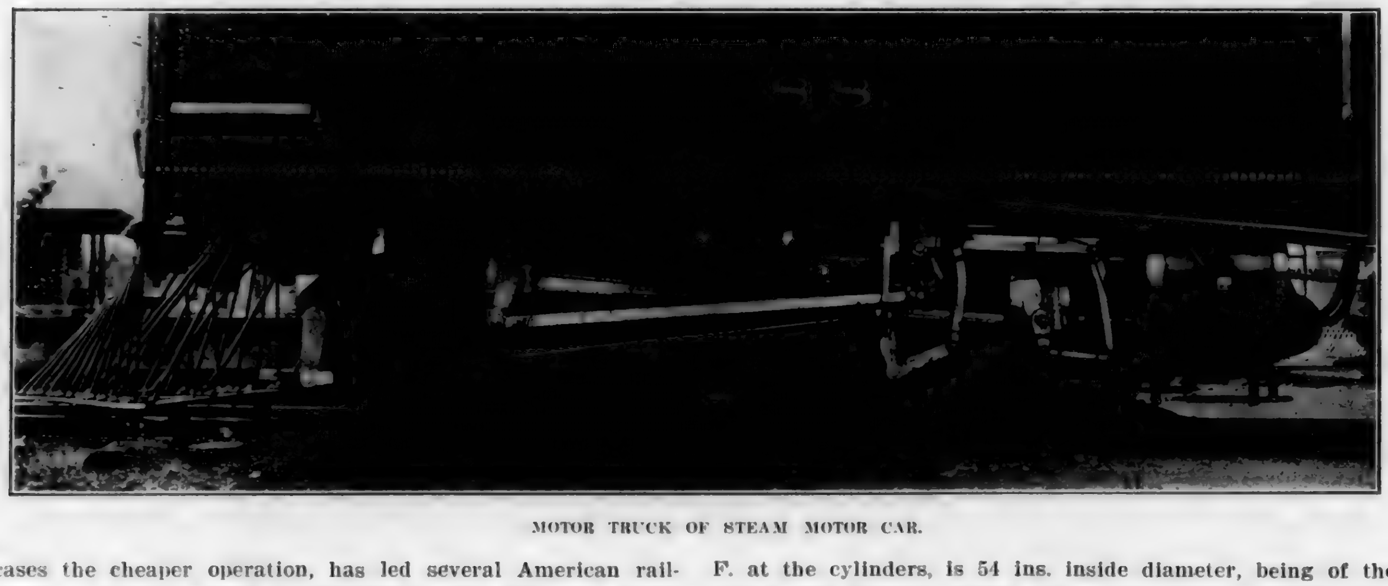

MOTOR TRUCK OF STEAM MOTOR CAR.

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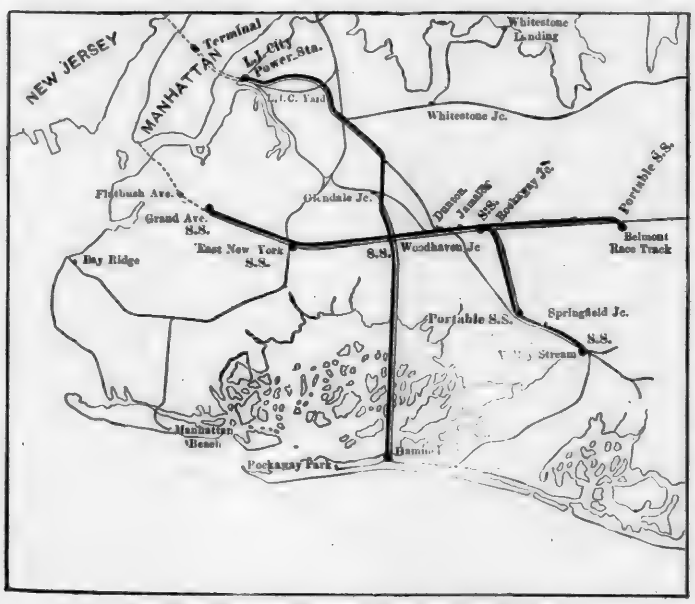
STEEL POLES AND TRANSMISSION LINES—LONG ISLAND R. R.



TRANSMISSION LINES—LONG ISLAND R. R.

ELECTRIFICATION OF THE LONG ISLAND RAILROAD

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In the issue of May, page 171, we gave a very complete illustrated description of the Long Island City power house of the Pennsylvania, New York, & Long Island Railroad, mentioning the fact that it was to furnish power for the operation of trains in the tunnels underneath the East River and the Island of Manhattan, being built by the Pennsylvania Railroad, and also for trains on certain portions of the Long Island Railroad.

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CANADIAN PACIFIC RAILWAY.

Experience with independently operated motor cars on steam railroads in this country has been confined largely to those operated by either gasoline engine direct or through the medium of an electric current from a dynamo driven by a gasoline engine located on the car, and several cars of both of these types have been illustated in this journal. The experience with motor cars on steam railroads in England and on the Continent has been, on the other hand, more extensive with cars driven by steam, and a number of successful designs have been in quite extensive service for a sufficient length of time to show that they can handle the traffic on certain branch and interurban lines with satisfaction and economy.

This successful foreign experience with steam-driven cars supplemented by several other reasons, such as the greater familiarity of trainmen with steam operation, the more satisfactory and convenient control as compared with direct-driven gasoline cars, the present greater reliability, and in some cases the cheaper operation, has led several American railroads to recently begin experimenting with this type, using in some cases cars purchased from special manufacturers, and in others cars designed and built at their own shops.

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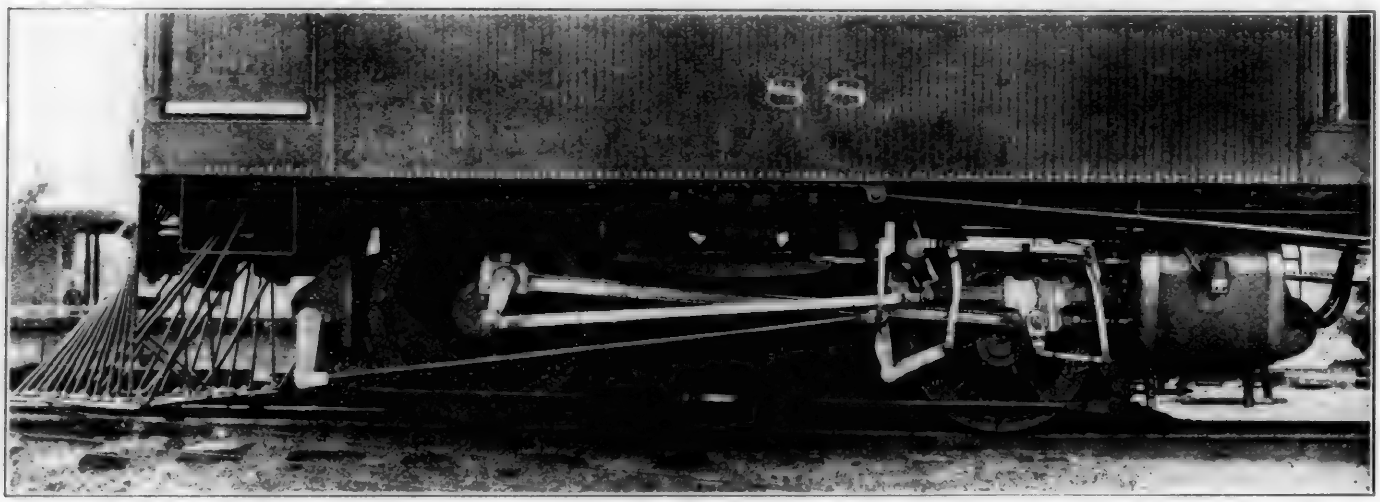

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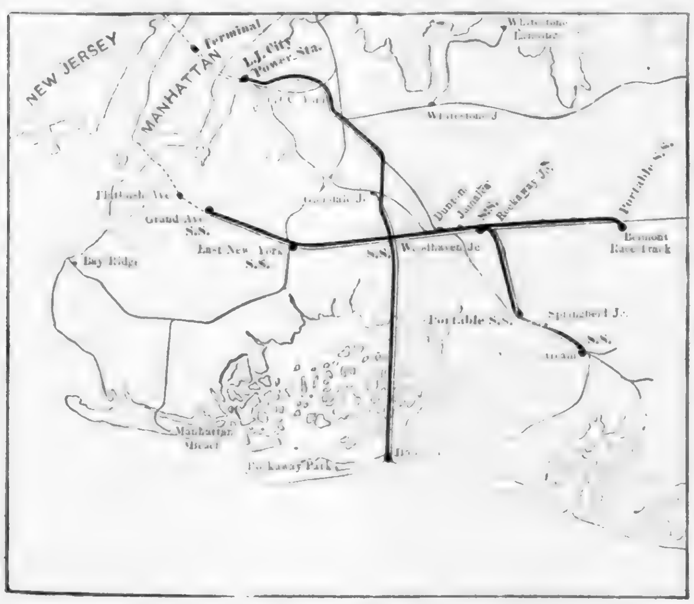

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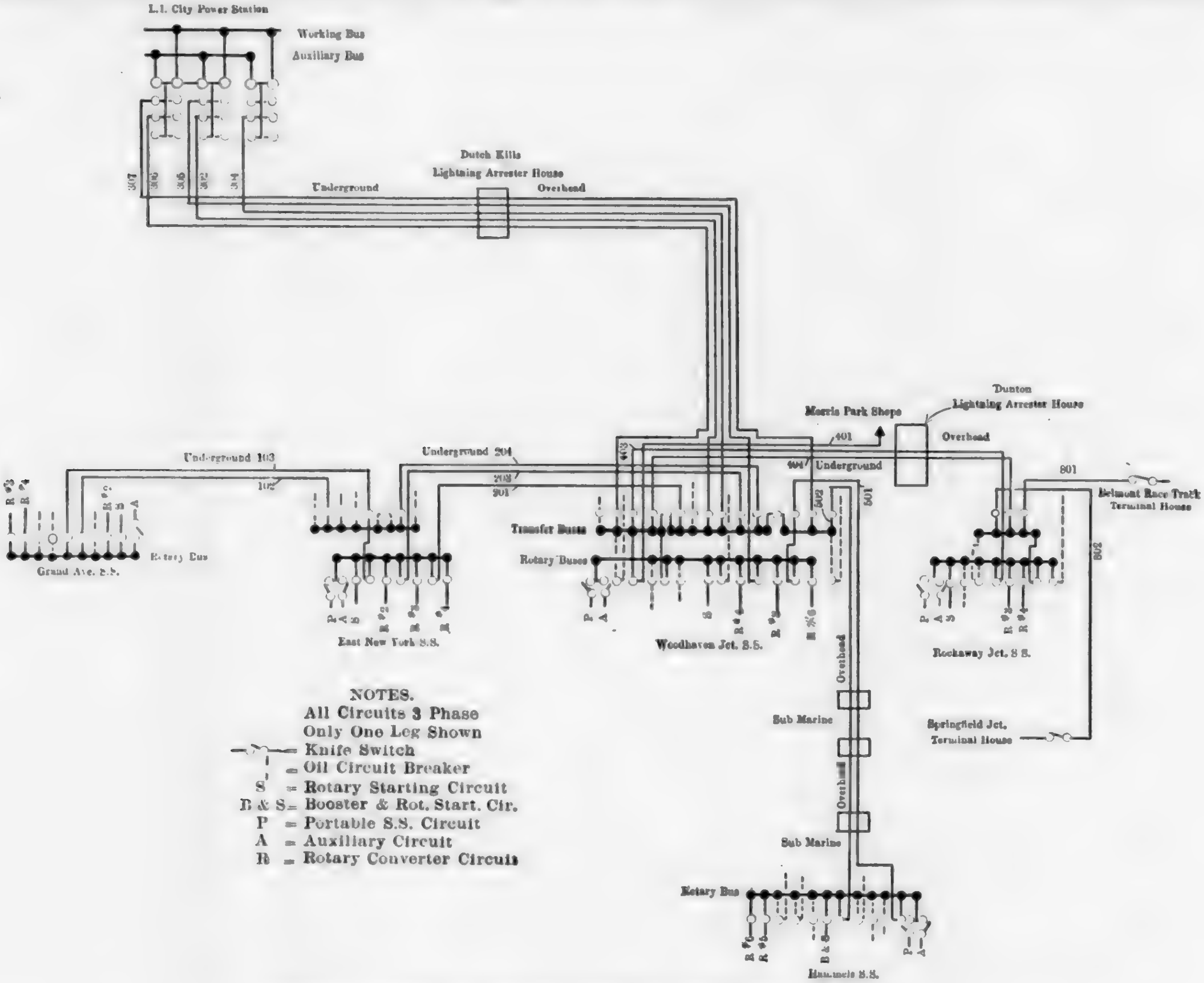

GENERAL DIAGRAM OF ELECTRIC CIRCUITS—LONG ISLAND R. R.

ing arrestors placed in a small building of fire proof construction. From this they are carried overhead on steel poles to Woodhaven Junction, a distance of 7.85 miles, where is located the largest and main sub-station, from which the current is distributed to the other sub-stations.

The conductors carrying the current consist of three cables having a cross section of 250,000 c.m., each being composed of 37 copper wires; the insulation has, of course, been given very careful attention and is suited to the conditions arising from the location of the circuit. Each length of cable was tested with a pressure of 30,000 volts after it was in place.

The overhead line between Dutchkill Street and Woodhaven Junction is carried on a special design of steel pole, the general appearance of which is shown in one of the illustrations. These poles are in various sizes to meet different conditions and are all designed to carry 24 high tension cables and 8 low tension cables each, the lowest cable being at least 25 ft. above the ground. The poles are built up of four corner angles connected together by angles and plates forming a lattice type of construction. They are tapered uniformly to the top on two sides and to within 7½ ft. of the top on the other two sides, the taper being ¾ of an in. per ft. This taper being uniform makes the size at the base of the pole vary with the height, the tops, however, being in all cases 6 by 11 ins. in section. At the bottom the corner angle irons are tied to a base composed of plates and channels through the corners of which the four anchor bolts pass. Each pole rests upon and is fastened to a concrete foundation of a size suitable to the pole and ground. Advantage is taken of the lighting rod qualities of the poles and each is grounded through a copper plate placed beneath the foundation and connected to one of the anchor bolts. The poles are designed to stand a wind pressure at right angles to a line corresponding to a wind velocity of 100 miles per hour. Poles of heavier construction than the standard are used for anchor poles and also at sharp curves in the line. The cross arms are all of yellow pine 5 by 6 ins. section and pass through the lattice work of the pole structure resting on angle iron seats at the sides and fastened by two U. bolts.

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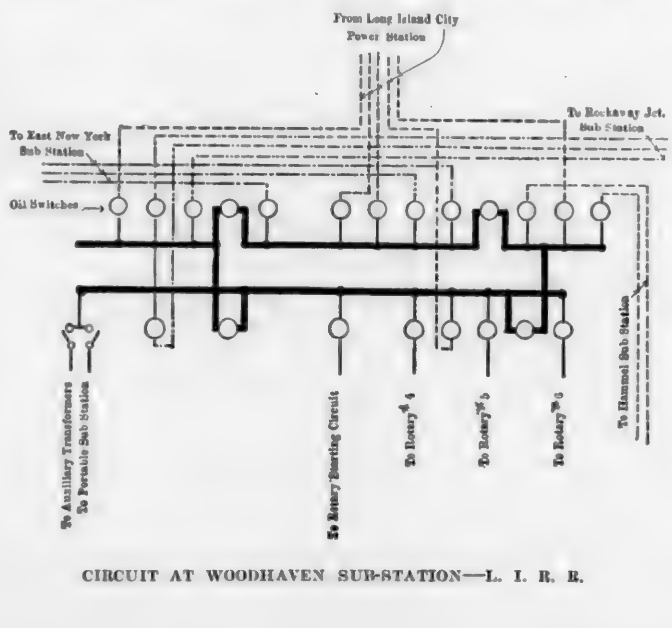

CIRCUIT AT WOODHAVEN SUB-STATION—L. I. R. R.

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At Woodhaven Junction special terminal racks are provided alongside the station, consisting of a steel truss bridge construction about 11 ft. wide and as long as the building, to which the transmission line is fastened. This rack, which is supported at the proper height by latticed steel columns, permits the cables to be dead ended where necessary, and the connection carried across into the sub-station by a cross connector at the most convenient point. This arrangement eliminates the crossing of the cables to a large extent and in no case is there less than 2 ft. clear between high tension cables. The five circuits from the power house are brought into the Woodhaven sub-station and connected through oil switches to a set of bus bars called the transfer buses, which are divided into sections from which the outgoing transmission circuits are led in various directions. From Woodhaven there are three high tension circuits leading due west along Atlantic Avenue, being carried in an underground conduit to the East New York sub-station, a distance of 3.23 miles. At this sub-station there is a smaller set of transfer buses, and from it are carried two high tension circuits continuing underground along Atlantic Avenue to Grand Avenue, a distance of 3.04 miles, where the sub-station forming the westerly terminus of the transmission line is located. Extending easterly from Woodhaven Junction there are two high tension circuits carried underground as far as Dunton, a distance of 1.7 miles, where they pass through a lighting arrestor house to an overhead circuit and continue to the Rockaway Junction sub-station located 1.73 miles east from Dunton. From this sub-station one high tension circuit is carried to a terminal house at Belmont Park, a distance of 3.71 miles, where a connection is arranged for a portable sub-station. Also from Rockaway Junction a circuit extends south to Springfield Junction, a distance of 3.33 miles, and from Springfield Junction to Valley Stream, a distance of 2.57 miles. From Woodhaven Junction two high tension circuits are carried overhead, except at points where it is necessary to cross wide bodies of water in which case they are carried through submarine cables, to Hammel substation, a distance of 6.98 miles.

In each sub-station are located transformers which reduce the voltage of the high tension current from 12,000 to about 375 volts. It is then passed through rotary converters which deliver it as direct current at 600 volts, in which form it is conducted directly to the third rail.

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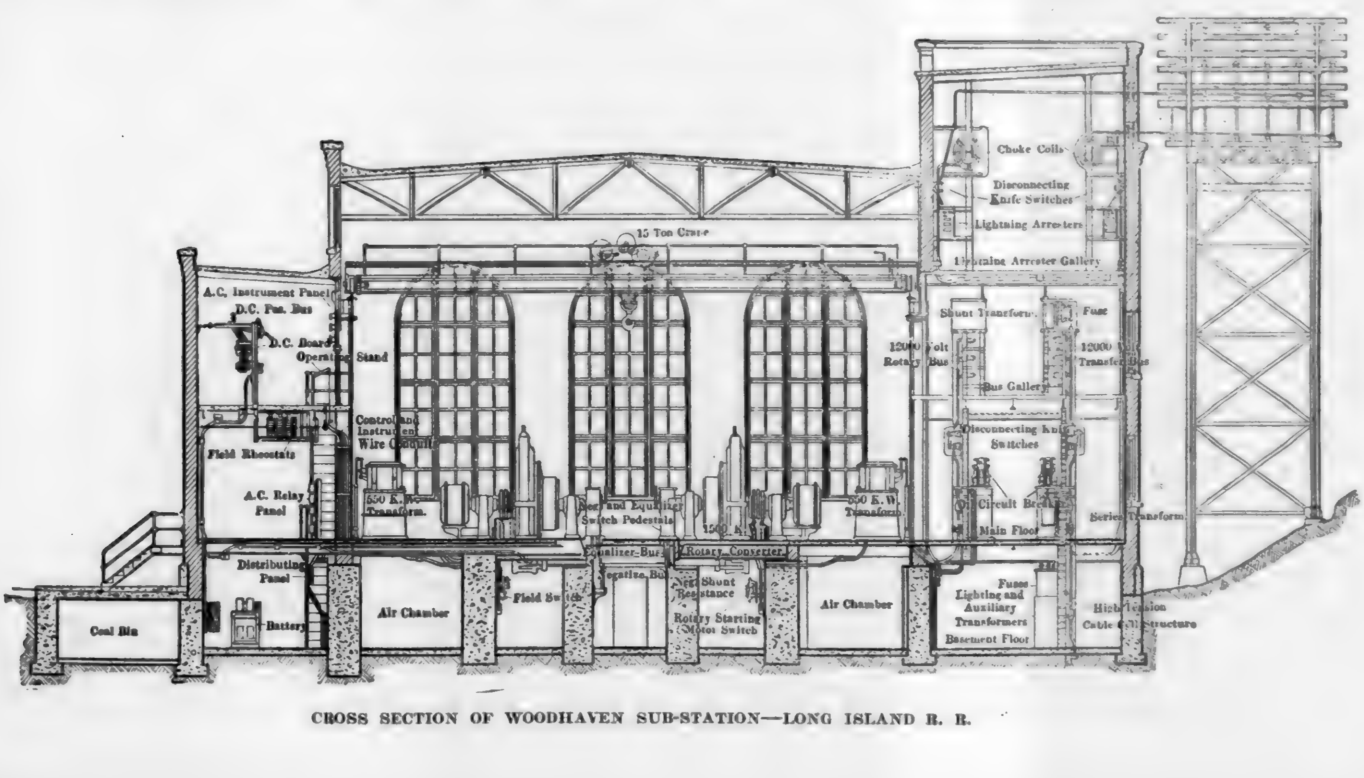
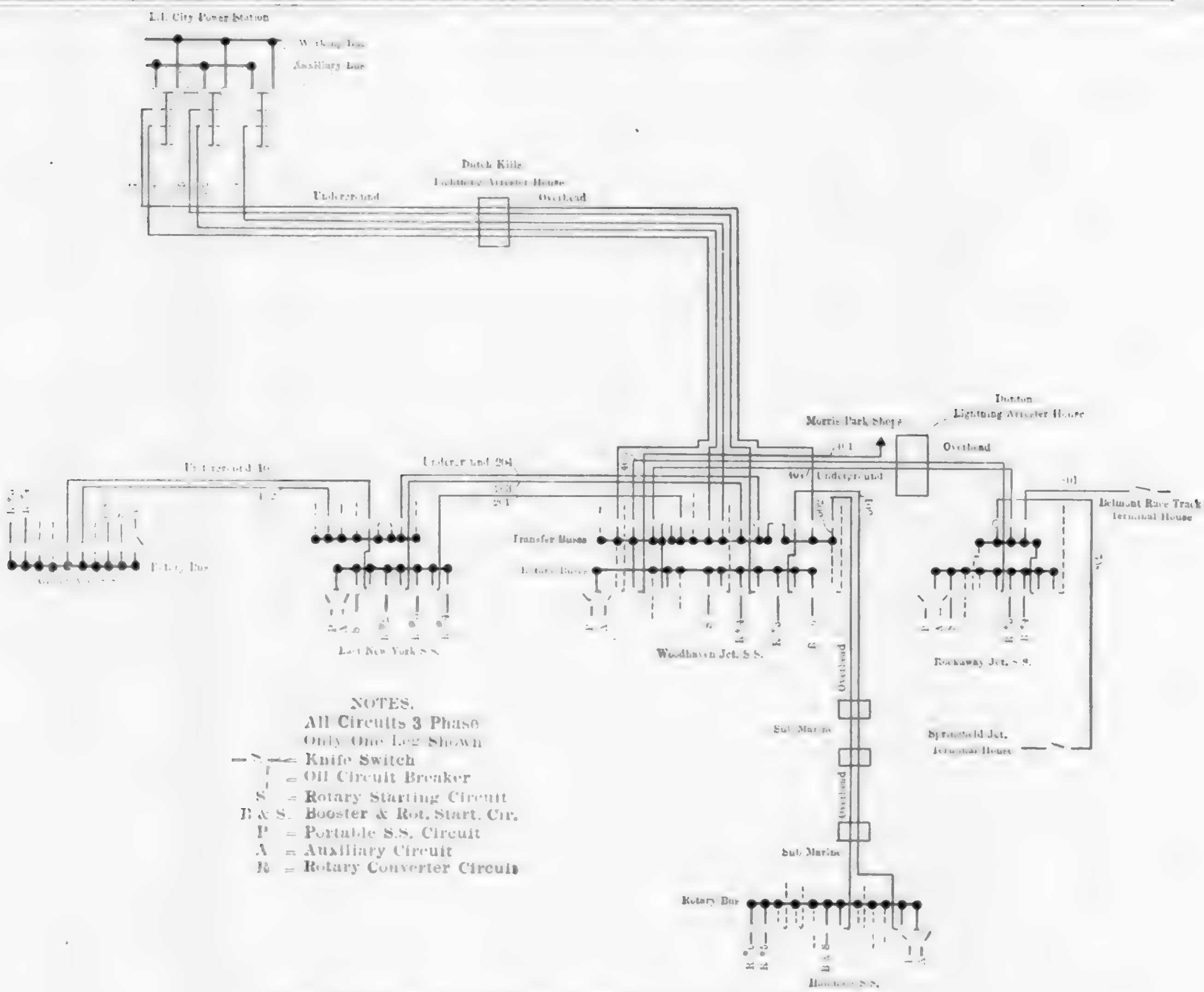


CROSS SECTION OF WOODHAVEN SUB-STATION—LONG ISLAND R. R.



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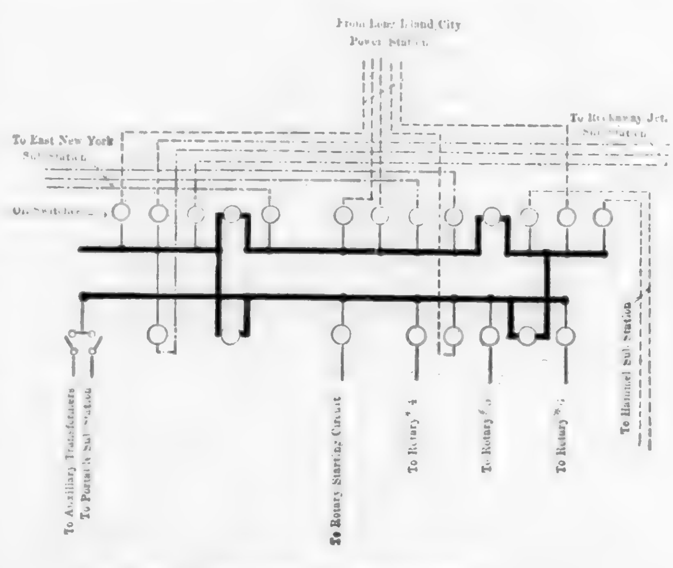

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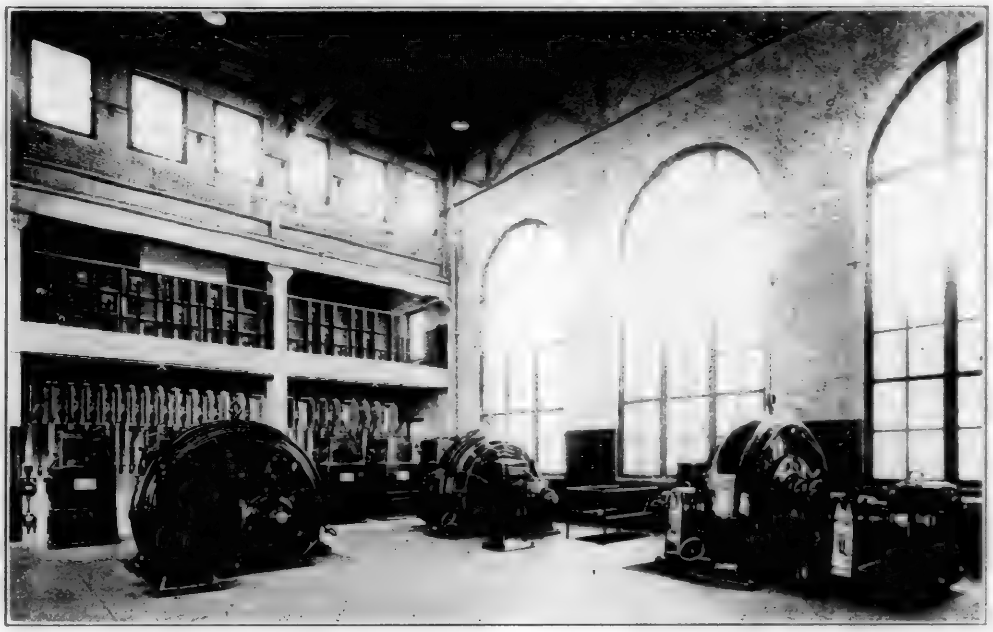

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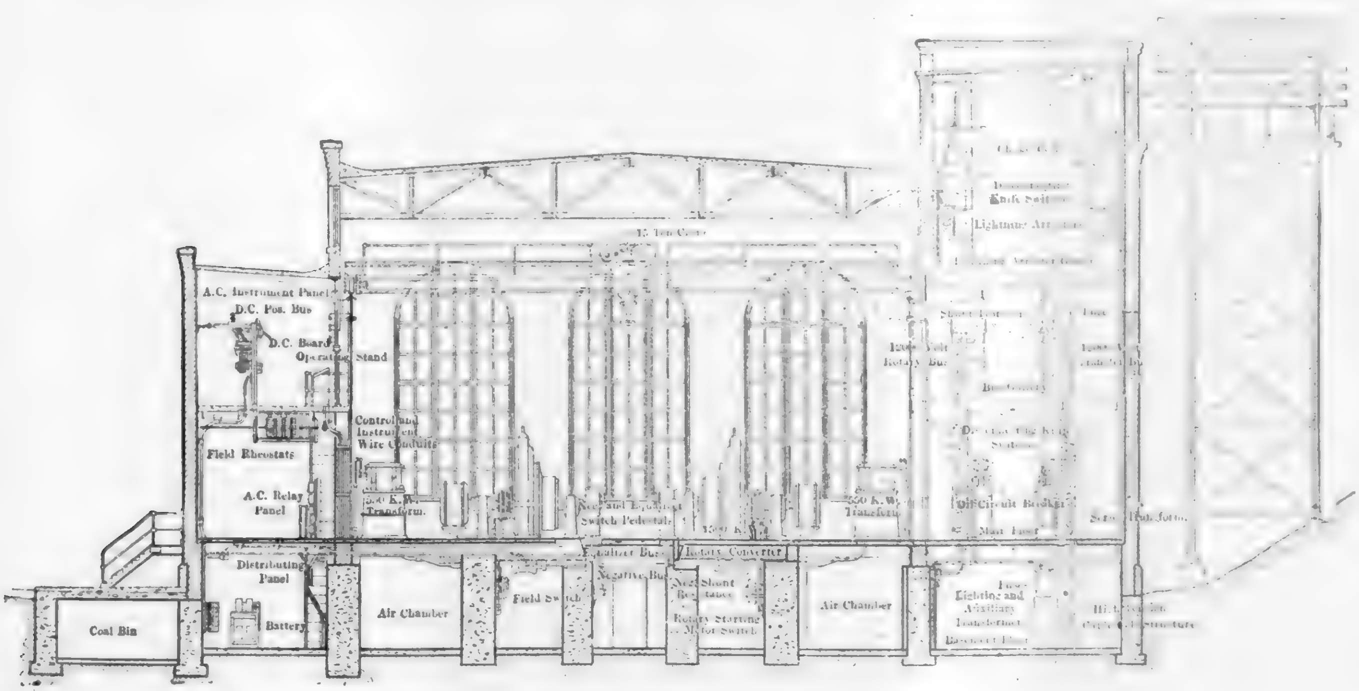


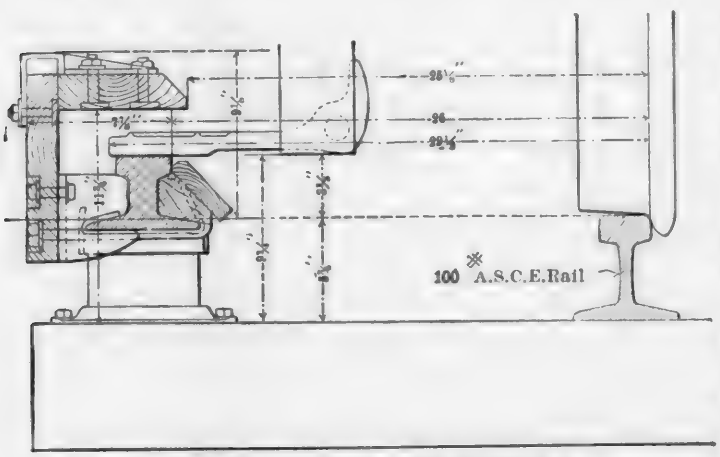
CROSS SECTION OF WOODHAVEN SUB-STATION—LONG ISLAND R. R.

maximum current that any future probable traffic would require, although at present but part of the equipment was needed and has been installed. At Grand Avenue, which is but a very short distance from Flatbush Avenue terminal, there are at present three 1,000 k.w. rotary converters and nine 375 k.w. transformers. Although space is provided for an ultimate capacity of five 1,500 k.w. converters and fifteen 550 k.w. transformers. The present capacity of the East New York sub-station is the same as that at Grand Avenue, but the ultimate capacity is somewhat smaller. The present equipment of the Woodhaven Junction station consists of three 1,500 k.w. converters and nine 550 k.w. transformers; the ultimate capacity being just double the present. At Rockaway Junction there are two 1,000 k.w. converters, six 375 k.w. transformers and two 162 k.w. boosters. At this point there is a storage battery of 3,200 ampere hour capacity at the one-hour rate.

The sub-station equipment also includes two portable sub-stations, each of which consists of a car containing one 1,000-k.w. rotary converter and three 375-k.w. transformers, together with the necessary blower, switchboard, circuit breaker, etc.

The storage battery was installed at Hammel, because this point is the farthest from the power station of any of the sub-stations and is connected by a transmission line occupying a somewhat exposed position in passing across Jamaica Bay, and is more liable to interruption in service by accident than any other part of the line. There is also a very large fluctuation in load at this point, due to the heavy travel to Rockaway Beach on summer afternoons and evenings. All sub-stations are constructed and arranged on the same general plan, and differ only in connection with their capacity; and hence the description of the Woodhaven Junction station will apply in its different features to the other stations.

The cross section of the Woodhaven sub-station herewith will give a very clear idea of the construction of the building and the arrangement of the apparatus. It will be seen that the rotary converters and transformers are located in the large central bay, which is flanked on either side by narrower bays, one of which is for high tension distribution and control apparatus and the other for the low tension instruments and the station operating board. The foundations of the transformers are open in the center for the passage of the air blast used for cooling, there being an electrically driven blower in each station which gives a pressure of one ounce per square inch, into the interior of these foundations, where it escapes through the proper passages and cools the windings. The high tension cables enter the building at Woodhaven in the top story of the high tension bay, where they connect to the lighting arrestors and choke coils. These are located on the third floor of this gallery. They are then carried down the outside wall into the basement where they cross beneath the floor and connect to the oil circuit breakers on the main floor. This bank of oil switches, directly underneath the bus bars located on the floor just above, controls all the circuits that enter and leave the buses. The two sets of bus bars and accompanying oil switches are located in a parallel line, the transfer buses being on the outside. The high tension circuits which are to leave the substation come from the proper section of the transfer bus down to an oil switch and thence beneath the floor to the underground conduit or on up along the wall to an overhead connection.



THIRD RAIL AND SHOE—LONG ISLAND R. R.

The circuits for the use of the sub-station pass down from the rotary bus bars through the oil switches, beneath the floor and thence directly to the transformers of which there are three 550 k.w. for each 1,500 k.w. rotary or three 375 k.w. for each 1,000 k.w. rotary. These transform the current from 12,000 volts to 400 volts and have taps arranged to enable the use of primary voltages down to 10,000 voltages and secondary voltages down to 340 voltages. From thence the circuit is again carried beneath the floor to the rotary converters which in the case of the 1,500 k.w. size are rated to deliver 2,400 amperes at 625 volts. These convert the current from alternating at 400 volts to direct current at 625 volts. The connections then pass beneath the floor to the low tension switchboard and after passing through the usual indicating and control instruments are conducted beneath the ground to the third rail at a point adjacent to the sub-station. The number of third rail connections vary with the number of tracks, switches, etc., in the vicinity. There are no feeder lines to the third rail between sub-stations and each sub-station connects to each adjacent sections of track, which sections are insulated with a space sufficient to prevent a single car from spanning the two sections, thus preventing burning out the car motors in case any section accidentally becomes grounded.


PORTABLE SUB-STATION AND HOUSE—L. I. R. R.

In the large sub-stations there are four sets of auxiliary transformers and in the others three sets, which supply current for driving the rotary converter starting motors, the transformer blower motors, the induction motor generating set, which is used to charge the small auxiliary storage battery that supplies current for the electric switch control system, and for the house lighting. These transformers are 50 k.v.a. capacity and receive their current from the rotary bus bars.

Most of the sub-stations have a track connection which permits the portable sub-stations to be run inside the building and connected up so as to temporarily increase the capacity of the station.

At Hammel, as above mentioned, there is a large storage battery which comprises 300 elements of the Electric Storage Battery Company, chloride accumulators, each element composed of 55 type R. plates. This battery has a normal one hour rating of 3,200 amperes and is so connected into the circuit that it automatically aids the rotary converter in carrying the peak of the load or absorbs the excess current.

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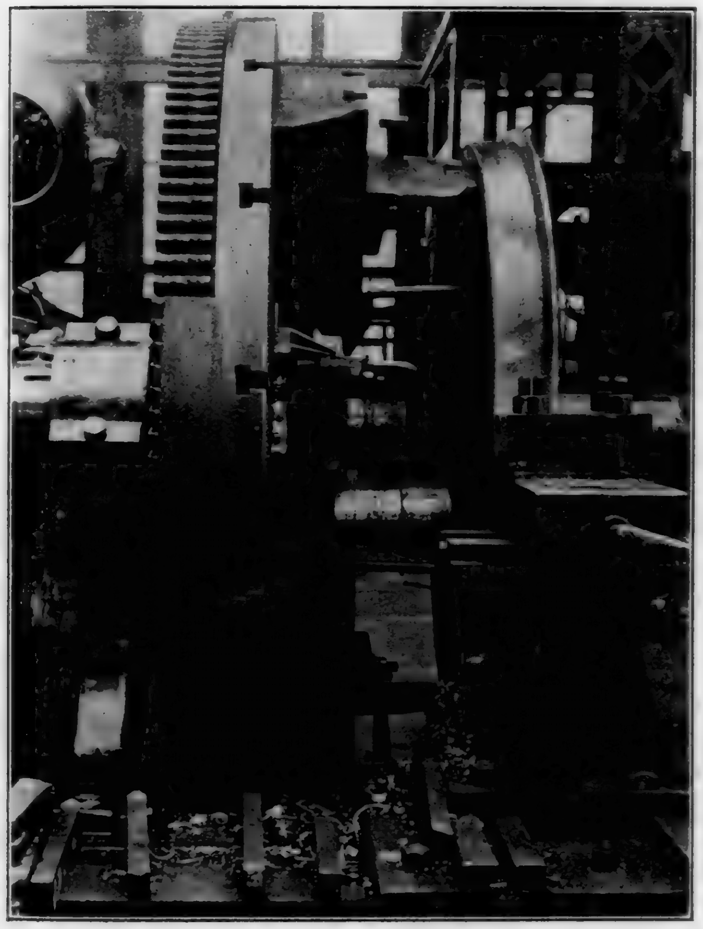

APPLICATION OF SURE GRIP DRIVERS TO WHEEL LATHE, L. S. & M. S. RY.

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The third rail used throughout the system is located with its gauge line 26 ins. from the inside gauge line of the running rail and with its top $3\frac{1}{2}$ ins. above the top of the track rail. It is of the top contact type and is protected with a horizontal type of guard extending directly over the rail as shown in the illustration herewith. The rail, which is of the T section 4 ins. high with a 3-in. head and 6-in. bottom flange, weighs 100 lbs. per yard and is mounted upon vitrified clay insulators, set on extra long ties at 10 ft. spaces. At each grade crossing it is necessary to discontinue the third rail and its circuit is continued by a cable in a concrete conduit underneath the road crossing and connecting to the section of the rail on the opposite side.

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The general testimony was that applications for men by employers were still much in excess of the number of graduates turned out.

maximum current that any future probable traffic would require, although at present but part of the equipment was needed and has been installed. At Grand Avenue, which is but a very short distance from Flatbush Avenue terminal, there are at present three 1,000 k.w. rotary converters and nine 375 k.w. transformers. Although space is provided for an ultimate capacity of five 1,500 k.w. converters and fifteen 550 k.w. transformers. The present capacity of the East New York sub-station is the same as that at Grand Avenue, but the ultimate capacity is somewhat smaller. The present equipment of the Woodhaven Junction station consists of three 1,500 k.w. converters and nine 550 k.w. transformers; the ultimate capacity being just double the present. At Rockaway Junction there are two 1,000 k.w. converters, six 375 k.w. transformers and two 162 k.w. boosters. At this point there is a storage battery of 3,200 ampere hour capacity at the one-hour rate.

The sub-station equipment also includes two portable sub-stations, each of which consists of a car containing one 1,000-k.w. rotary converter and three 375-k.w. transformers, together with the necessary blower, switchboard, circuit breaker, etc.

PORTABLE SUB-STATION AND HOUSE—L. I. R. R.

The storage battery was installed at Hammel, because this point is the farthest from the power station of any of the sub-stations and is connected by a transmission line occupying a somewhat exposed position in passing across Jamaica Bay, and is more liable to interruption in service by accident than any other part of the line. There is also a very large fluctuation in load at this point, due to the heavy travel to Rockaway Beach on summer afternoons and evenings. All sub-stations are constructed and arranged on the same general plan, and differ only in connection with their capacity; and hence the description of the Woodhaven Junction station will apply in its different features to the other stations.

The cross section of the Woodhaven sub-station herewith will give a very clear idea of the construction of the building and the arrangement of the apparatus. It will be seen that the rotary converters and transformers are located in the large central bay, which is flanked on either side by narrower bays, one of which is for high tension distribution and control apparatus and the other for the low tension instruments and the station operating board. The foundations of the transformers are open in the center for the passage of the air blast used for cooling, there being an electrically driven blower in each station which gives a pressure of one ounce per square inch, into the interior of these foundations, where it escapes through the proper passages and cools the windings. The high tension cables enter the building at Woodhaven in the top story of the high tension bay, where they connect to the lighting arrestors and choke coils. These are located on the third floor of this gallery. They are then carried down the outside wall into the basement where they cross beneath the floor and connect to the oil circuit breakers on the main floor. This bank of oil switches, directly underneath the bus bars located on the floor just above, controls all the circuits that enter and leave the buses. The two sets of bus bars and accompanying oil switches are located in a parallel line, the transfer buses being on the outside. The high tension circuits which are to leave the substation come from the proper section of the transfer bus down to an oil switch and thence beneath the floor to the underground conduit or on up along the wall to an overhead connection.

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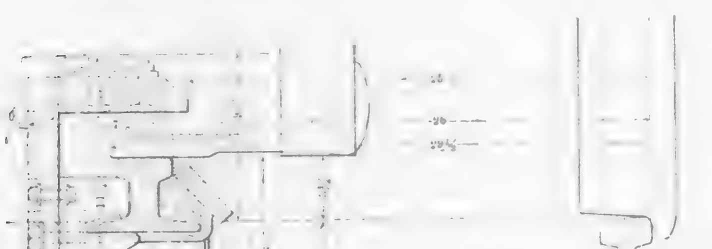

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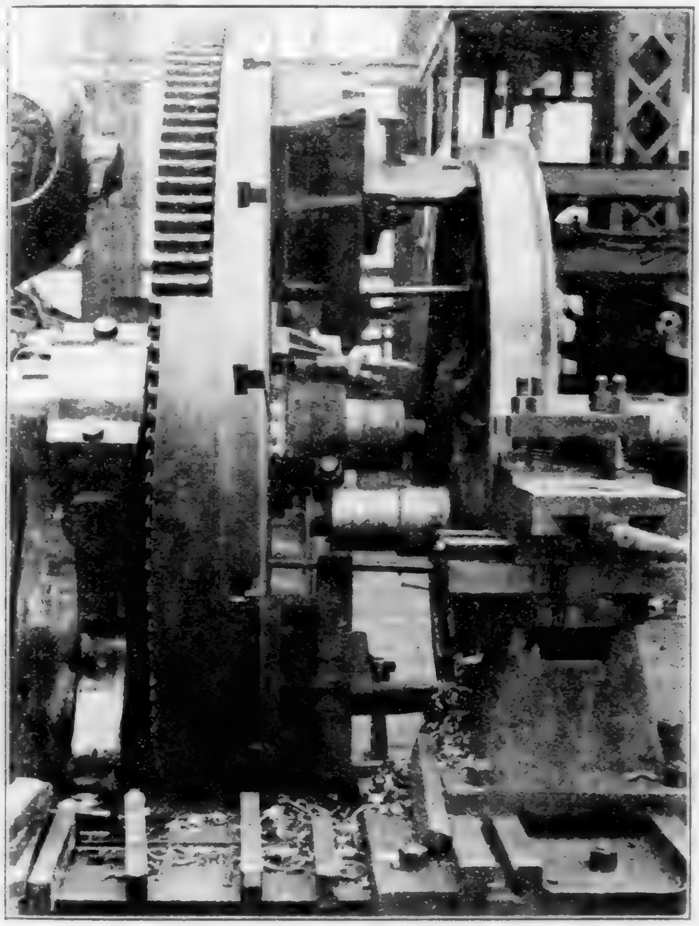

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Metallurgy		11

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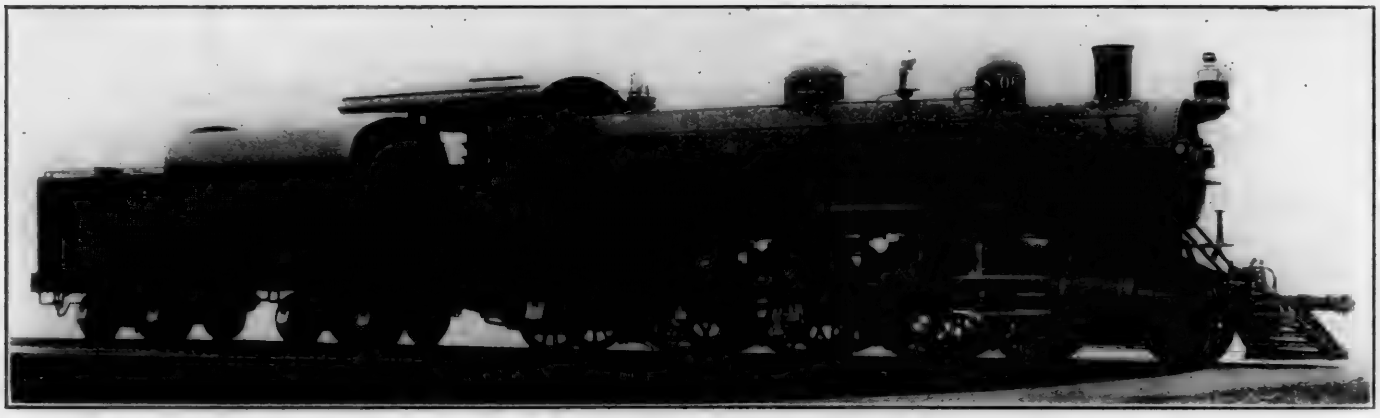
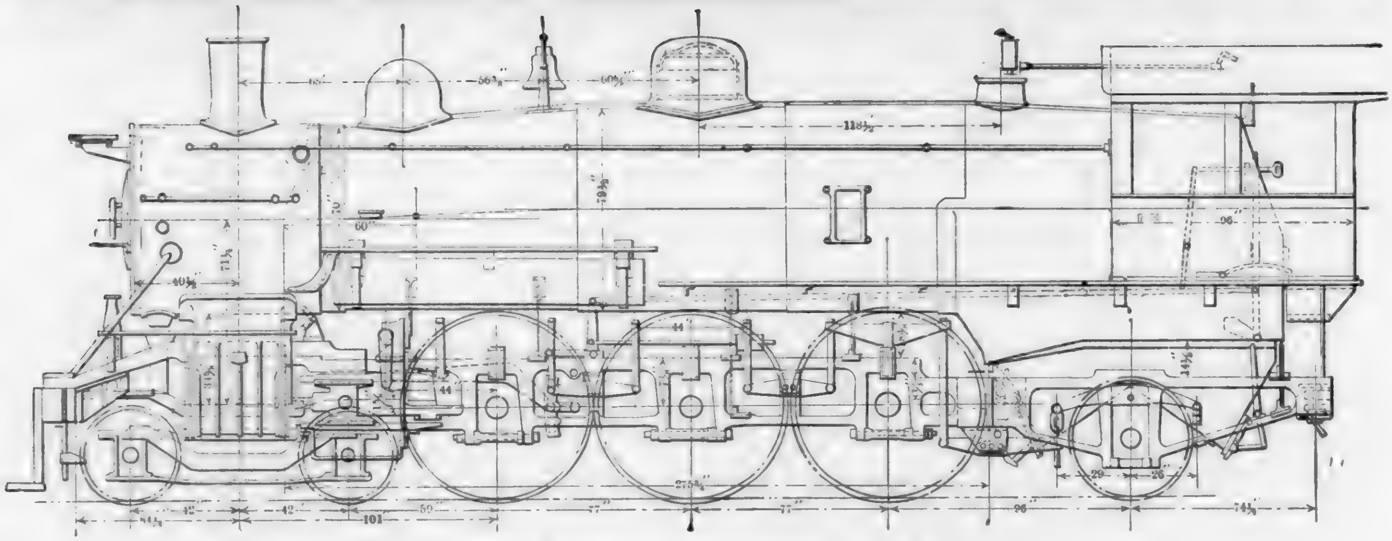


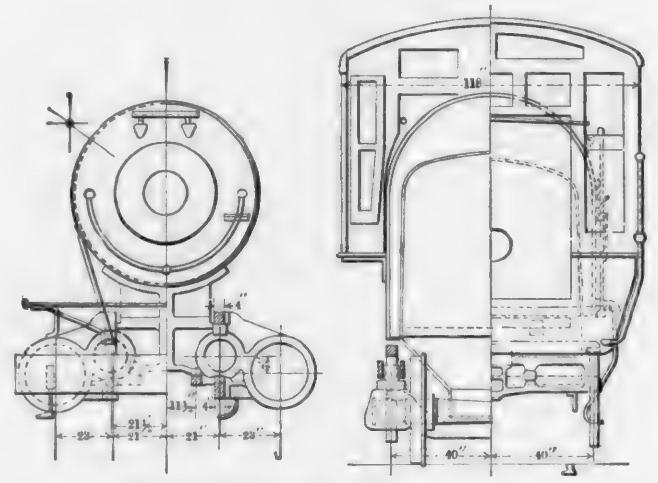


PACIFIC TYPE PASSENGER LOCOMOTIVE—C. B. & Q. RY.

PACIFIC AND PRAIRIE TYPE LOCOMOTIVES.

CHICAGO, BURLINGTON & QUINCY RAILWAY.

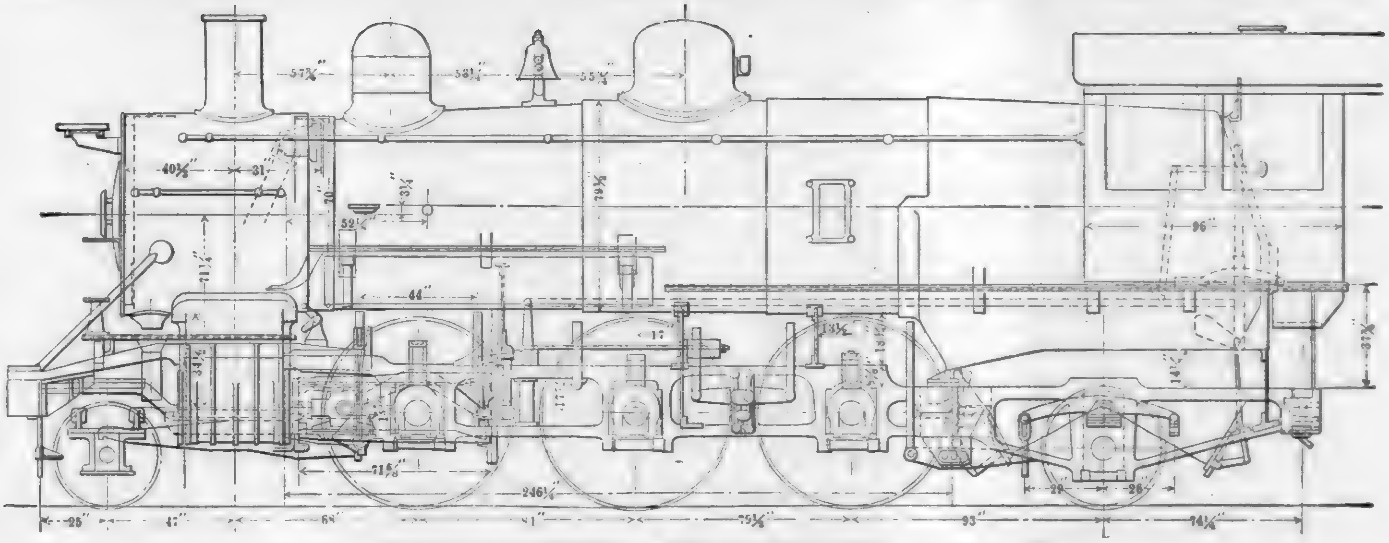
Early in the year 1900 the Chicago, Burlington & Quincy Railway built at its own shops some Prairie type locomotives, being the pioneers in the present development of the use of the wide firebox with large grate areas, for burning soft coal. (See AMERICAN ENGINEER, April, 1900, pp. 103.) These engines were built after designs prepared by Mr. F. A. Delano, superintendent of motive power and Mr. F. H. Clark, then mechanical engineer. They were known in the railroad company's classification as Class R1 and included several original ideas of design, particularly in the construction and arrangement of the trailer truck and frame under the firebox. They had 19 by 24-in. cylinders, 64-in. wheels and a steam pressure of 190 lbs., which gave a tractive effort of 21,860 lbs. The total weight was 138,000, of which 94,000 lbs. was on drivers.



SECTIONS OF PACIFIC TYPE LOCOMOTIVE.

	R1.	R2.	R3.	R4.	R5.	S1.
Total Weight	138,000	171,000	181,920	212,500	216,000	230,940
Weight on Drivers	94,000	130,000	134,550	154,000	159,540	151,290
Tractive Effort	21,860	25,500	28,300	35,060	35,060	32,690
Steam Pressure	190 lbs.	200 lbs.	200 lbs.	210 lbs.	210 lbs.	210 lbs.
Size, Cylinders	19 x 24	20 x 24	21 x 26	22 x 28	22 x 28	22 x 28
Wheel, Diameter	64	64	69	69	69	74
Total Heating Surface	1,958	2,888.5	3,060.5	3,514	3,576	3,933
Grate Area	42	42	42	54	54	54
Tractive Effort × Dia. Drivers ÷ Heating Surface	717	565	640	687	677	615
Weight on Drivers ÷ Heating Surface	48	45	44	43.6	44.6	38.5
Vol. Cyls., cu. ft.	7.88	8.74	10.4	12.32	12.32	12.32
Total Heating Surface ÷ Vol. Cyls.	248	330	294	285	290	318

TABLE GIVING GENERAL DIMENSIONS OF PRAIRIE AND PACIFIC TYPE LOCOMOTIVES—C. B. & Q. RY.



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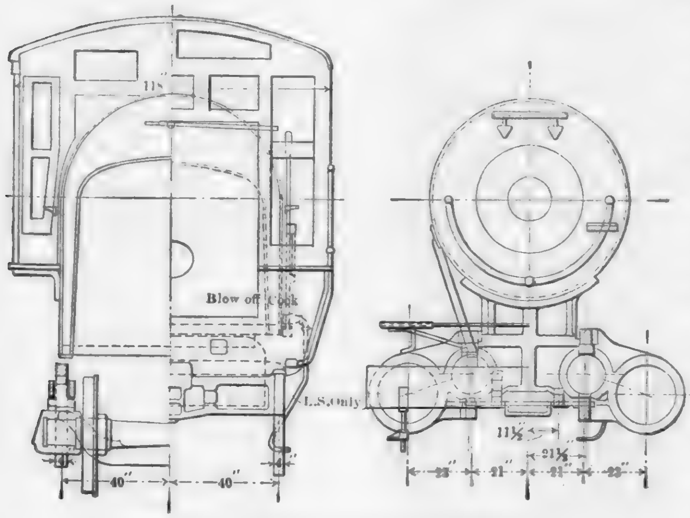


SECTIONS OF PRAIRIE TYPE LOCOMOTIVES.

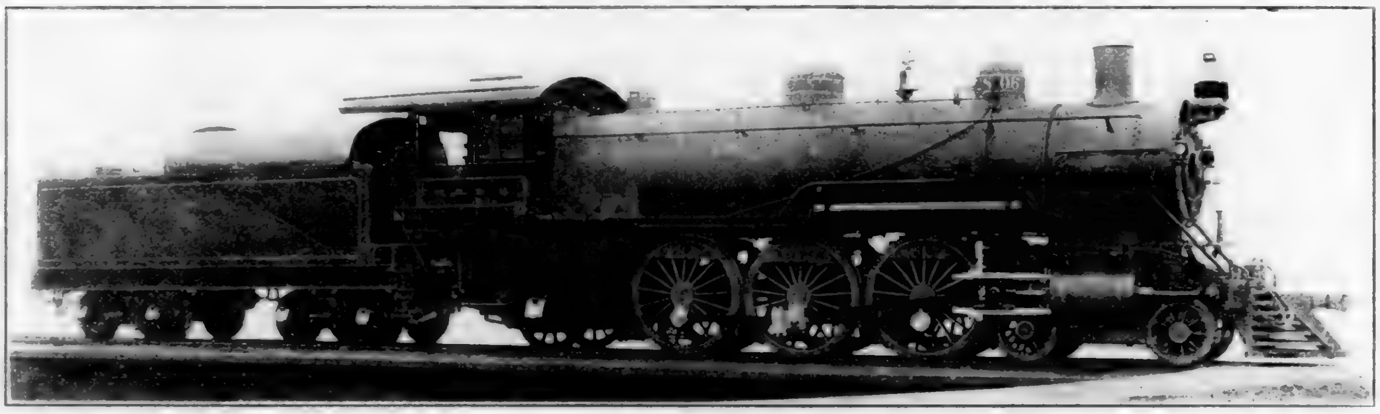
These were followed shortly after by the Class R2, which was in general an enlargement of the preceding class and had 20 by 24-in. cylinders, 64-in. wheels and 200 lbs. of steam pressure. This second class was followed later by Classes R3 and R4, which had 21 by 26 and 22 by 28-in. cylinders respectively, both having 69-in. drivers. The latter of these had its steam pressure increased to 210 lbs., and also differed from the preceding three classes in the use of the radial stay boiler in the place of the Belpaire. There was also a change made in the location of the valve chamber on the Class R4, it being placed between the double bar front frame instead of over the cylinder as in the previous classes.

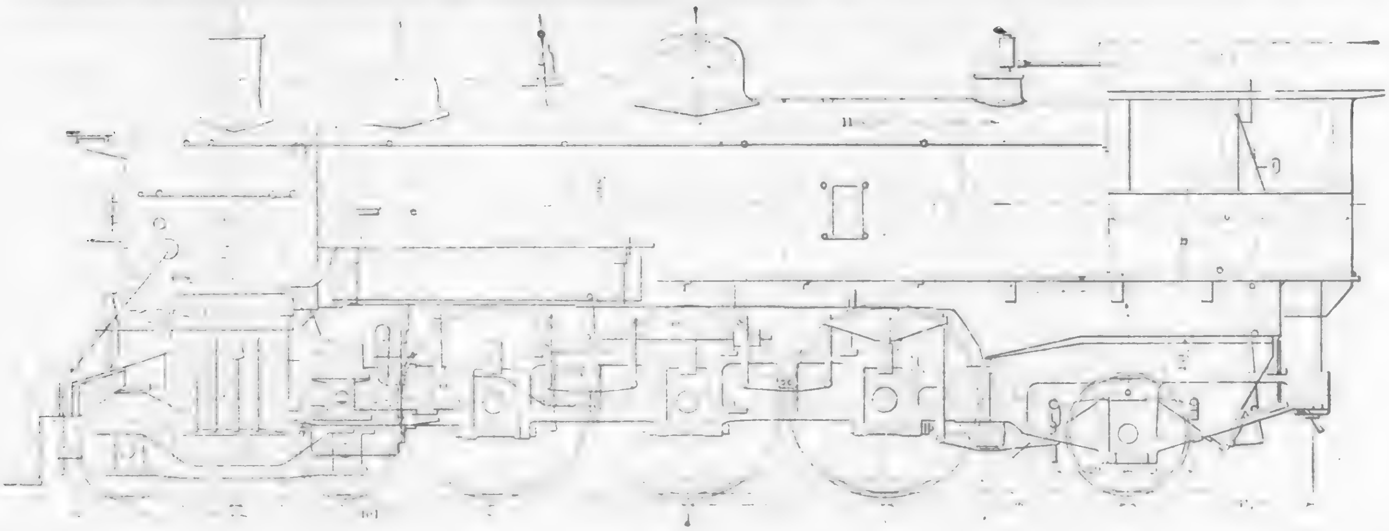
These four classes were described and illustrated in the AMERICAN ENGINEER AND RAILROAD JOURNAL in the following numbers: April and July, 1900, pages 103 and 217; May, 1901, page 135; November, 1902, page 343 and March, 1905, page 78.

The latest step in the development of this particular type of locomotive on the C. B. & Q. Ry. is shown in an order recently received from the Baldwin Locomotive Works, which are titled Class R5 and are illustrated herewith. These engines differ but slightly from the Class R4, which fact can be taken as an evidence that for the service required, which is largely fast freight and moderate speed heavy passenger, they have proved to be entirely satisfactory as far as power and general design are concerned.

The most noticeable change made is the return to the wagon-top boiler, which was used on the first three classes in place of the straight boiler used on the Class R4. However, the diameter at the front ring is the same on the Class R4, and the barrel from the second ring backward has been enlarged to 79½ ins., giving a considerable increase in steam storage space. This addition to boiler capacity has resulted in a slight increase in the weight on drivers and total weight, but in other respects the two engines are essentially alike.

In connection with this order of Prairie types, of which there were 50 built, there were 15 Pacific type locomotives built by the same company, which are very similar to them. The principle changes made, are in the boiler shell which has been lengthened about 2 ft., and in the wheel spacing which has been changed to allow three 74-in drivers and a four-wheel leading truck, instead of a two-wheel truck. The extension of the boiler shell was accompanied by an extension in the flue length, making the flues in the Pacific type engine 21 ft. long. This is, we believe, with the exception of the Mallet compound locomotive of the Baltimore & Ohio Railroad, the first example of flues of this length in this country.





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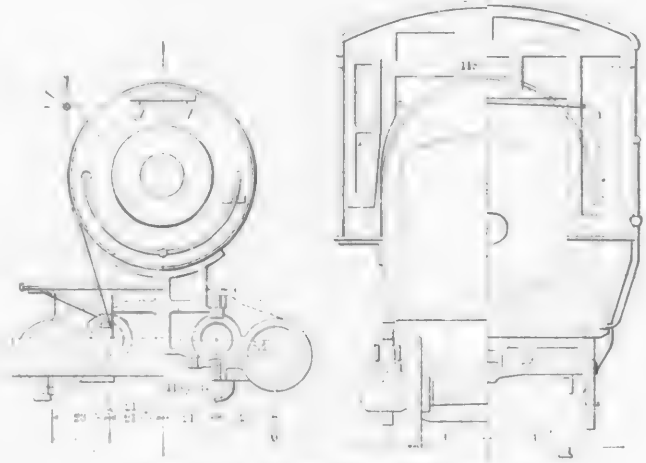

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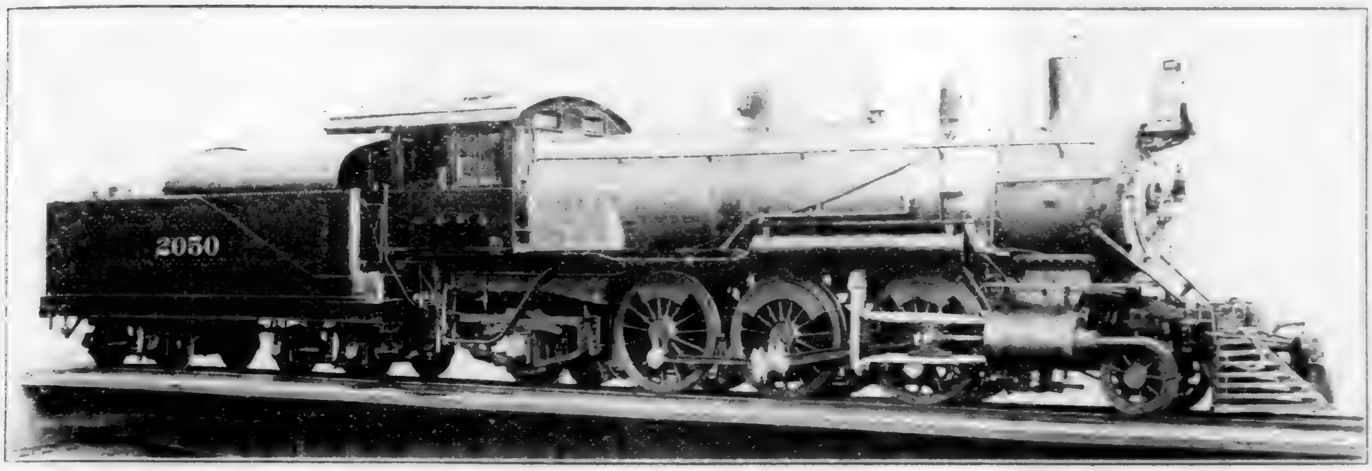

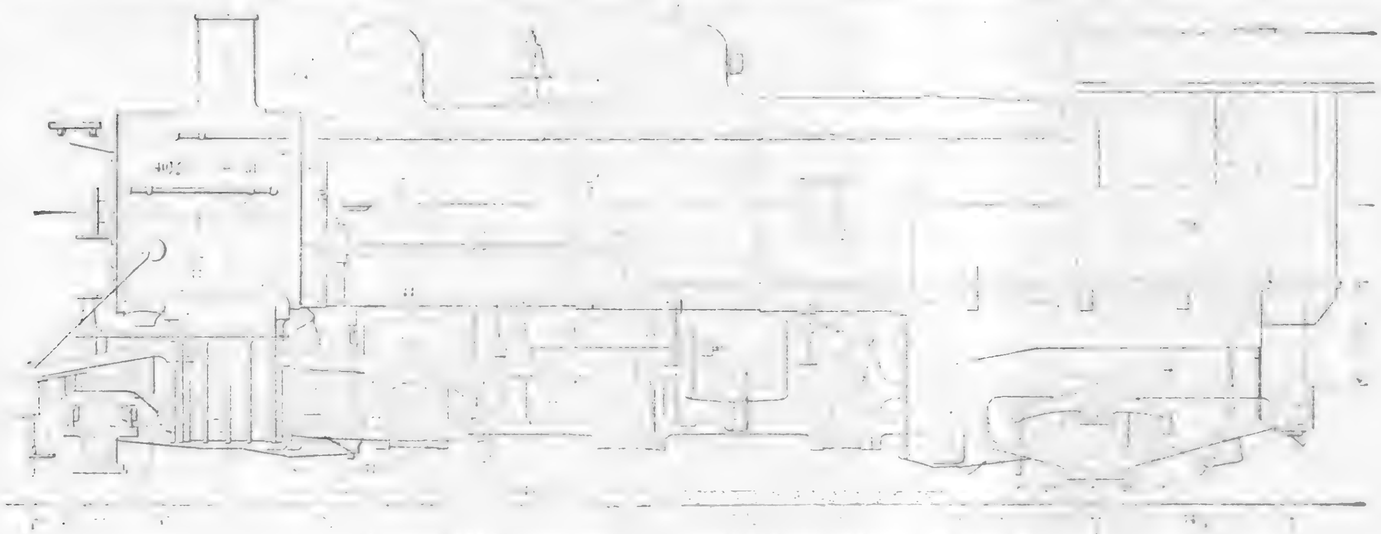

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These four classes were described and illustrated in the AMERICAN ENGINEER AND RAILROAD JOURNAL in the following numbers: April and July, 1900, pages 103 and 217; May, 1901, page 135; November, 1902, page 342 and March, 1905, page 78.

The latest step in the development of this particular type of locomotive on the C. B. & Q. Ry. is shown in an order recently received from the Baldwin Locomotive Works, which are titled Class R5 and are illustrated herewith. These engines differ but slightly from the Class R4, which fact can be taken as an evidence that for the service required, which is largely fast freight and moderate speed heavy passenger, they have proved to be entirely satisfactory as far as power and general design are concerned.

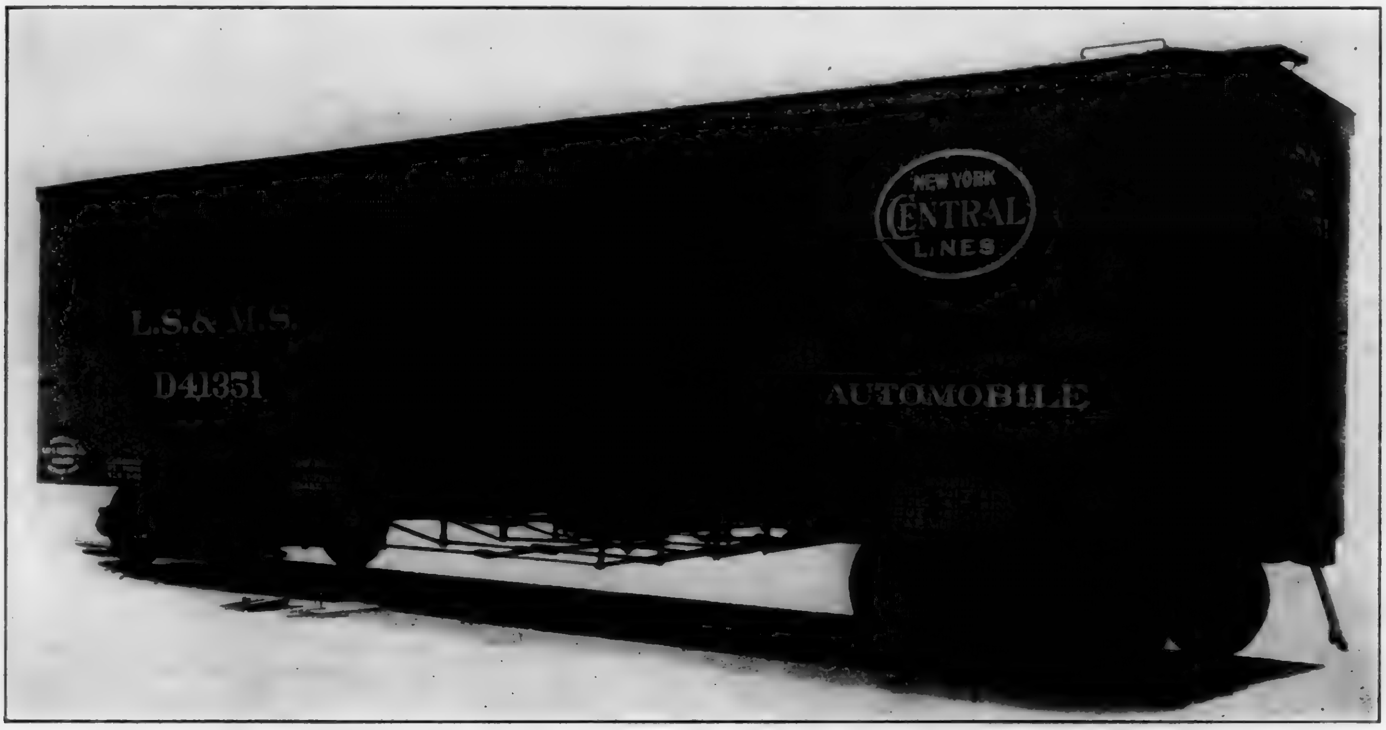
The most noticeable change made is the return to the wagon-top boiler, which was used on the first three classes in place of the straight boiler used on the Class R4. However, the diameter at the front ring is the same on the Class R4, and the barrel from the second ring backward has been enlarged to 79½ ins., giving a considerable increase in steam storage space. This addition to boiler capacity has resulted in a slight increase in the weight on drivers and total weight, but in other respects the two engines are essentially alike.

In connection with this order of Prairie types, of which there were 50 built, there were 45 Pacific type locomotives built by the same company, which are very similar to them. The principle changes made, are in the boiler shell which has been lengthened about 2 ft., and in the wheel spacing which has been changed to allow three 74-in drivers and a four-wheel leading truck, instead of a two-wheel truck. The extension of the boiler shell was accompanied by an extension in the flue length, making the flues in the Pacific type engine 21 ft. long. This is, we believe, with the exception of the Mallet compound locomotive of the Baltimore & Ohio Railroad, the first example of flues of this length in this country.

The Pacific type engine, which is known as Class S1, weighs 230,940 lbs. total, of which 151,290 lbs. is on drivers and has a tractive effort of 32,690 lbs. In these three respects, which are a direct gage of the power of the locomotive, it ranks among the heaviest and most powerful of the type on our records, being exceeded in total weight only by the balanced compound Pacific type for the Oregon Railway and Navigation Company and in weight on drivers and tractive effort by the balanced compound Pacific type of the Atchison, Topeka and Santa Fe, to both of which engines it is a very close second.

The accompanying table gives the general dimensions of each step of this direct progression in the locomotive design from the first of the Prairie type built in 1900, and it will be seen that during the five years there has been an increase of 60 per cent. in tractive effort between the R1 and the R5 and 56½ per cent. increase in total weight. The similarity of the Classes R4 and R5, however, would indicate that the future will show but little further increase in these respects and that the greater attention is now being given to improvements of details of design and operation as a solution of the increased traffic requirements.

VALVES.		
Kind	Piston	Piston
Diameter	12 ins.	12 ins.
WHEELS.		
Driving, diameter over tires	69 ins.	74 ins.
Driving, thickness of tires	3½ ins.	4 ins.
Driving journals, all dia. and length	9½ x 12 ins.	9½ x 12 ins.
Engine truck wheels, diameter	37¼ ins.	37¼ ins.
Engine truck journals	6 x 10 ins.	6 x 12 ins.
Trailing truck wheels, diameter	42½ ins.	48 ins.
Trailing truck, journals	8 x 12 ins.	8 x 12 ins.
BOILER.		
Style	W. T.	W. T.
Working pressure	210 lbs.	210 lbs.
Outside diameter of first ring	70 ins.	70 ins.
Firebox, length and width	108⅛ x 72¼ ins.	108⅛ x 72¼ ins.
Firebox plates, thickness	⅜ & ½ in.	⅜ & ½ ins.
Firebox, water space	4½ & 4 ins.	4½ & 4 ins.
Tubes, number and outside diameter	303-2¼ ins.	303-2¼ ins.
Tubes, length	19 ft.	21 ft.
Heating surface, tubes	3,370 sq. ft.	3,732 sq. ft.
Heating surface, firebox	190 sq. ft.	190 sq. ft.
Heating surface, total	3,576 sq. ft.	3,933 sq. ft.
Grate area	54 sq. ft.	54 sq. ft.
Centre of boiler above rail	108⅝ ins.	110 ins.
TENDER.		
Tank	Water bottom	Water bottom
Frame	Steel	Steel
Wheels, diameter	33 ins.	37¼ ins.
Journals, diameter and length	5½ x 10 ins.	5½ x 10 ins.
Water capacity	8,000 gals.	8,000 gals.
Coal capacity	16 tons.	16 tons.



AUTOMOBILE AND FURNITURE CAR, LAKE SHORE AND MICHIGAN SOUTHERN RY.

The following table gives the general dimensions, weights and ratios of these two types.

FREIGHT AND PASSENGER LOCOMOTIVES.

CHICAGO, BURLINGTON & QUINCY RY.

Type	2-6-2	4-6-2
Service	Freight	Passenger
Fuel	Bit. coal.	Bit. coal
Tractive effort	35,060 lbs.	32,690 lbs.
Weight in working order	216,000 lbs.	230,940 lbs.
Weight on drivers	159,540 lbs.	151,290 lbs.
Weight on leading truck	22,800 lbs.	38,650 lbs.
Weight on trailing truck	33,660 lbs.	41,000 lbs.
Weight of engine and tender in working order	368,000 lbs.	382,000 lbs.
Wheel base, driving	13 ft. 4½ ins.	12 ft. 10 ins.
Wheel base, total	30 ft. 8½ ins.	32 ft. 9 ins.
Wheel base, engine and tender	62 ft. 2¾ ins.	64 ft. 3¼ ins.
RATIOS.		
Weight on drivers ÷ tractive effort	4.55	4.63
Total weight ÷ tractive effort	6.16	7.07
Tractive effort x dia. drivers ÷ heat. surface	677	615
Total heating surface ÷ grate area	648	713
Firebox heat. surface ÷ total heat. surface %	5.34	4.85
Weight on drivers ÷ total heating surface	44.6	38.5
Total weight ÷ total heating surface	60.7	59
Volume both cylinders	12.32 cu. ft.	12.32 cu. ft.
Total heating surface ÷ vol. cylinders	290	318
Grate area ÷ vol. cylinders	4.46	4.46
CYLINDERS.		
Kind	Simple	Simple
Diameter and stroke	22 x 28 ins.	22 x 28 ins.

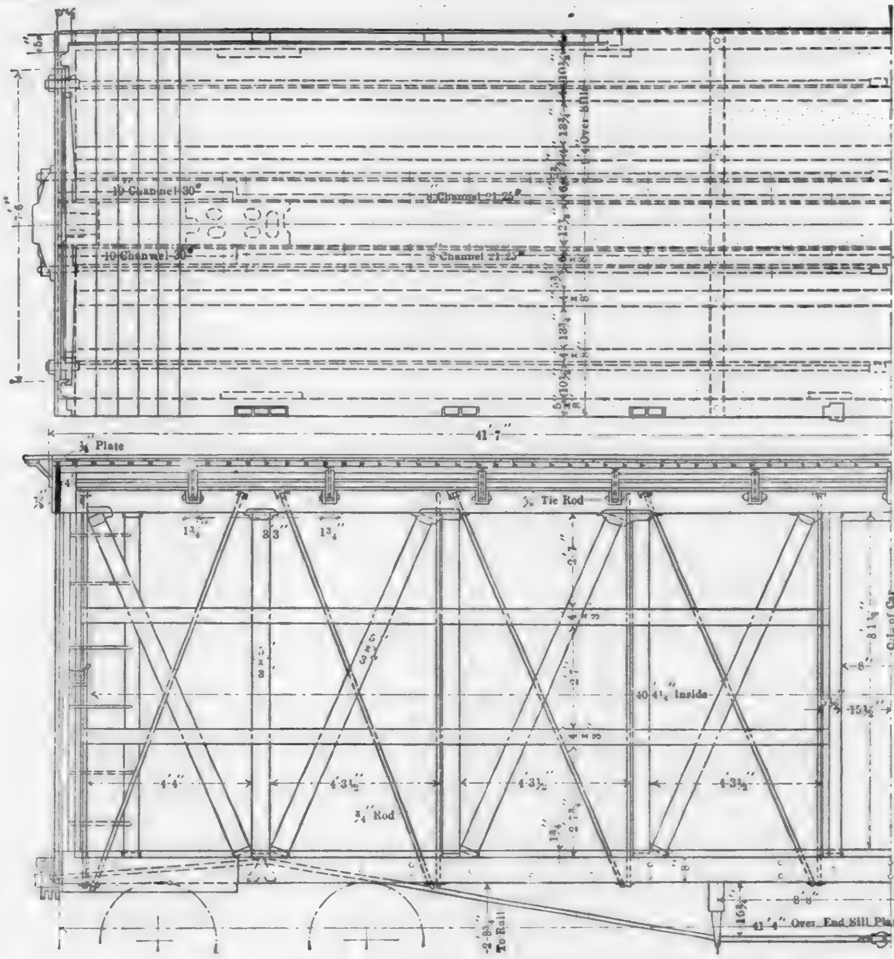
AUTOMOBILE AND FURNITURE CAR.

LAKE SHORE AND MICHIGAN SOUTHERN RAILWAY.

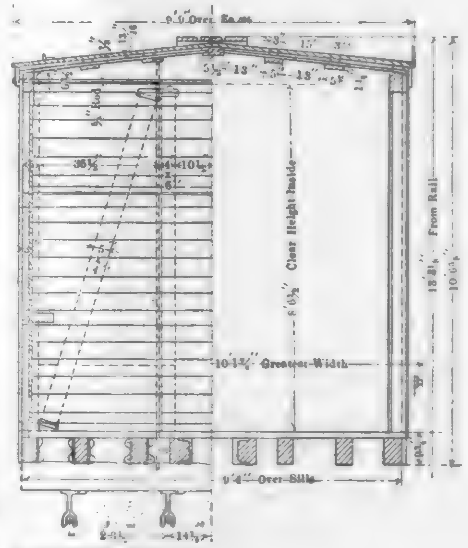
The Lake Shore & Michigan Southern Railway is having 1,000 box cars built at the West Detroit Works of the American Car and Foundry Company, which are specially arranged for carrying automobiles. Traffic of this nature requires a car of large inside dimensions, large door openings and of fairly large weight capacity. For fulfilling these requirements, the car, which is shown herewith, has an inside length of 40 ft. 4½ ins., and a width of 8 ft. 8 ins.; three wide door openings, one in the end of the car giving a clear opening of 7 ft. 6 ins. by 8 ft. 3 ins., and the other two located on either side, although not directly opposite each other, giving a clear opening of 8 ft. by 8 ft. 1¼ ins., and has a capacity of 80,000 lbs., its floor level being but 42⅝ ins. above the rail.

In general the construction is very similar to a modern furniture car of like size. The end door, however, occupying as it does practically the full width of the car, made special construction necessary at that point and the low floor level necessitated a draft gear application of especial interest.

The underframe comprises eight wooden sills, the two



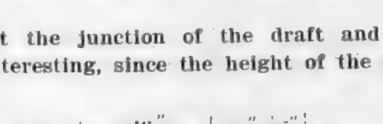
extends for the full width of the car and is cut out in the centre for the coupler shank. A malleable iron casting, the top of which is flush with the car floor, is fitted between the sills spanning the draft gear and is securely riveted to the 10 in. channels and to the end sill reinforcing plate. Its construction and location is shown in the illustration of the draft gear. On the outside of the end sill plate is another malleable iron casting, which spans the opening above the coupler shank



FRAMING OF AUTOMOBILE CAR, LAKE SHORE AND MICHIGAN SOUTHERN RY.

centre sills being 6 by 8 ins., the side sills 5 by 8 ins., and the intermediate sills 4 by 8 ins. All of these, with the exception of the centre sills, which terminate at the outer side of the bolster on either end, extend continuous between end sills. The center sills are reinforced by 8-in. chanels with flanges turned outward, which are fitted and bolted to the inner side of the wooden sills. From the bolster to the end sills the center sills are made up of 10 in. channels stiffened by 6 in. by 10 in. timbers. The two channel sections of the center sills are thoroughly tied together by a malleable iron casting which serves as a distance piece for the center sills and fits over the bolster, being securely riveted and bolted to both the reinforcing channels and wooden sills. This construction gives the car a set of steel draft sills. The wooden part of the center sills between the bolster and the end sills is so interlocked and bolted that they can be easily removed for the purpose of repairing the steel draft rigging and yet stiffen the draft sills for buffing strains. This construction will be made clear by referring to the illustration of the draft gear application. The underframe is stiffened by four 1¼ in. truss rods, which extend from the end sill over a chair at the bolster and are 15¾ ins. below the sills at the queen posts.

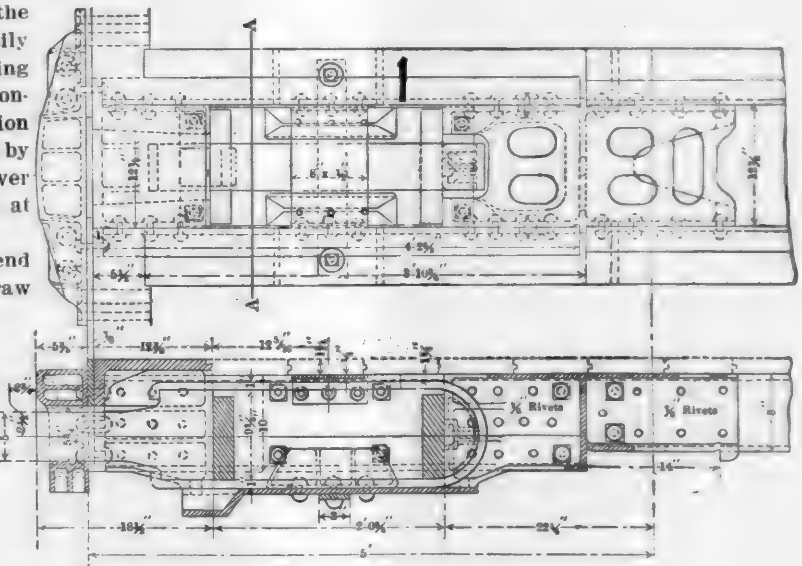
The construction at the junction of the draft and end sills is particularly interesting, since the height of the draw bar makes it necessary to discontinue the wooden end sills at the inner edge of both draft sills. The end sills are reinforced by a ¾ in. plate on the outer face, which



Section A-A

and extends far enough on either side to take in the two center truss rods. This casting is securely riveted and bolted to the end sill and its plate as well as to the casting between the draft sills just mentioned, and makes up the strength and stiffness of the sill which was lost by cutting the opening for the coupler shank.

The construction of the car body, with the exception of the end containing the large doors, offers nothing unusual. The placing of a large door in the end of the car made it necessary to introduce the use of steel to get the required strength and stiffness at this point. The construction is shown in one of the illustrations. It will be seen that a

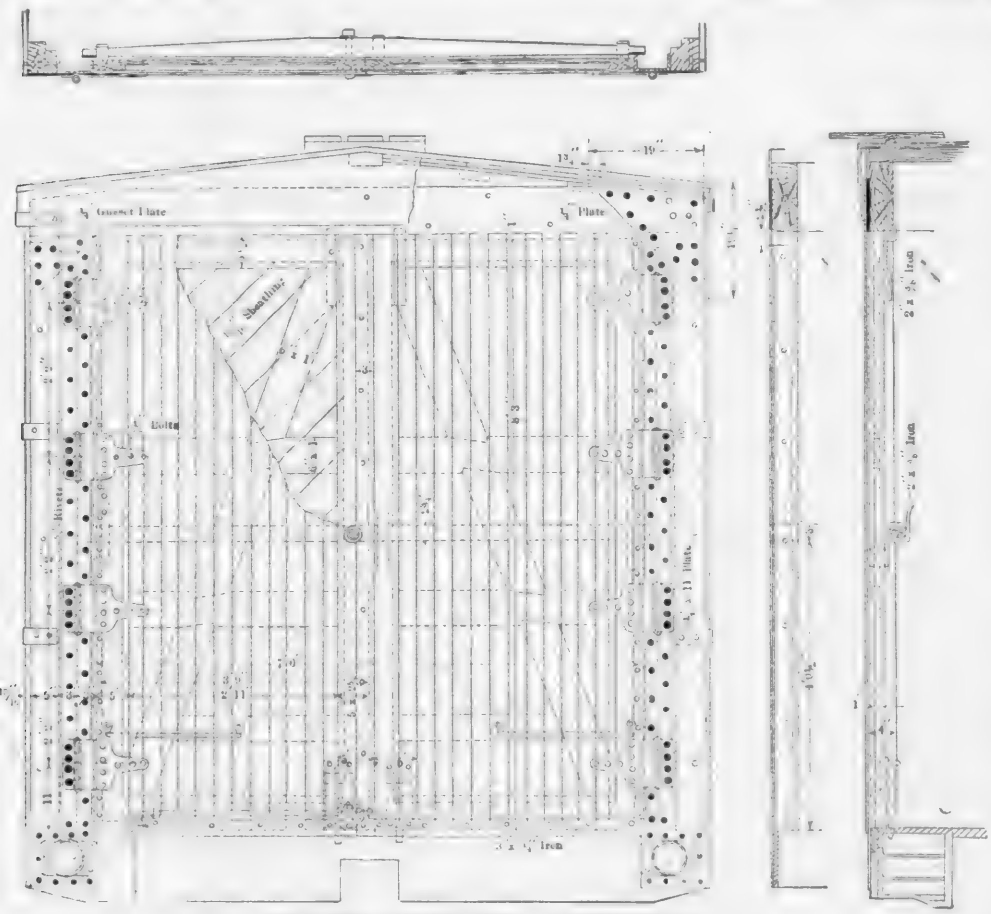


DRAFT GEAR APPLICATION ON AUTOMOBILE CAR.

¼ in. x 11 in steel plate is placed flush on the outside of the corner post. This is riveted to the end sill plate at the bottom and secured at the top by means of a gusset to a ¼ in. x 8 in. steel plate, which in turn is bolted to the wooden end plate.

The plates at the corner post are reinforced by two angle irons placed back to back, the inner one serving as a door jam and the outer one fitting against the corner post and furnishing additional means of fastening thereto. In this manner the end of the car is stiffened by a square frame work of steel plates around the door opening, securely bolted to the wooden frame work, the corner posts and end plate being the only wooden members of the car body at this point. The doors, themselves are of wood stiffly and substantially constructed and fitted with a locking bar in the center and bolted at the top and bottom. The hinges are so constructed as to give a clear opening of 7 ft. 6 in. when the doors are open.

It will be noticed that the uncoupling shaft arrangement is fastened to the door.



END DOOR CONSTRUCTION, AUTOMOBILE CAR.

The cast steel bolsters are fastened to the sills in the usual manner and are made as shallow as possible. The trucks are of the standard arch bar type.

The draft gear is of the Westinghouse friction design. Its application is clearly shown in the illustration.

We are indebted to Mr. R. B. Kendig, mechanical engineer of the road, for the drawings and information.

Mr. C. W. Van Buren has been appointed divisional car foreman of the Eastern Division of the Canadian Pacific Railway, with headquarters at Montreal.

Mr. W. E. Dunham, mechanical engineer of the Chicago & Northwestern Ry., has been appointed master mechanic on the same line at Winona, Minn.

Mr. Robert Job has resigned as chemist of the Philadelphia & Reading Ry. to become a member of the firm of Booth, Garrett, & Blair, analytical and engineering chemists, of Philadelphia.

A RATIONAL METHOD FOR THE INTRODUCTION AND MANAGEMENT OF PIECE-WORK IN A RAILROAD SHOPS.*

WILLIAM S. COZAD.†

Fourteen months ago on the Erie Railroad, with which I am connected, we commenced the work of perfecting a piece-work organization in each of the ten different shops on that road. At three of these points the shops employ an average of 1,000 men each; the seven remaining plants each average from 250 to 500 men. I am speaking now of the locomotive shops exclusively, although it might be mentioned in this connection that within the period stated above, the entire car department, the master car builder of which is a thorough piece-work man, has been reorganized and placed on a sound piece-work basis.

In the locomotive shops, however, where progress along piece-work lines is necessarily slow on account of the complex nature of the work, and also where it becomes necessary to change almost every condition before satisfactory prices can be fixed, we decided on, and have since perfected, the piece-work organization explained further on.

Piece-work, so called, was in effect in but three of the shops on the road. This made the task more difficult in these shops than at points where no prices were effective, on account of the very disorderly way in which the rates were fixed and applied. Many of the prices in effect were too high, others too low, and the descriptions of the different operations, which were written years ago, were very meager and not understood even by the foremen of the different departments whose duty it was to apply them. There were no piece-work inspectors or time checkers in the different departments of the piece-work shops. Each employee was his own piece-work and daily time checker, turning in his work and time on different operations on a blank form provided for the purpose. To correct these and many other errors, to thoroughly organize a piece-work system and place it on a sound basis in each of the different shops, to so conduct the management of the shops that the piece-work principle would appeal to all classes of the workers as being fair in its application, we outlined and have since perfected the following organization:

Mechanical superintendent, assistant mechanical superintendent, a shop specialist or piece-work expert, master mechanic of each shop, general foreman, time-keeping department, a time specialist, having the title of assistant to the general foreman, for each shop, a piece-work checker for each sub-department in shops large enough to justify it; in the small shops two or three departments are combined.

The general duties of the mechanical superintendent are well known and need no explanation here, further than to note that he finally approves each separate price before it is put into effect.

The jurisdiction of the assistant mechanical superintendent extends in a general way over all shop operations, including

*From a paper presented before the New England Railroad Club.
†Shop Specialist, Erie Railroad Company.

roundhouse expenses, shop buildings, machinery, shop ouput, etc. All appointments of general foreman, gang foremen, and piece-work checkers are made by him, subject to the approval of the mechanical superintendent, recommendations for such appointments and promotions being first made by the different master mechanics.

The shop specialist reports to and receives instructions from the mechanical superintendent, and also works in harmony with the assistant mechanical superintendent, as their interests in relation to piece-work are mutual. All piece-work schedules are made and records kept in the office of the shop specialist, as will be hereafter explained.

† Form 2351—6, 1905—5m.

ERIE RAILROAD COMPANY.

Shop ______ **Date** ______

Description of Operation and Material ______

Machine ______ *Time Started* ______ *Time Finished* ______

SPEED		FEED PER REV.		TIME-MINUTES		TIME-MINUTES		Time to Change and Grind Tools	Total Time	Pattern	Class
Rough Cut	Finish Cut	Rough Cut	Finish Cut	Rough Cut	Finish Cut	To Set	To Remove		Minutes	Number	of Engine

Name of Workman ______ *Day Rate* ______

Remarks : ______

Assistant to Gen'l Foreman.

FIG. 1.

The assistant to the general foreman is the man upon whom rests the responsibility for fixing the time upon which all piece-work prices are based. He is in many respects the most important factor in the entire piece-work organization. No piece-work expert, I care not how proficient he may become in the business, can handle all the details of rate fixing on a large railroad without relying more or less on the judgment of the man who makes the recommendations from personal observation of the work. It is to these men, therefore, who time the work personally, that we must look for fair treatment of the workmen as well as a proper conception of responsibility to the company.

These positions are made attractive both in point of salary and in placing men in line for promotion to roundhouse foreman, general foreman, master mechanics, etc., and we have aimed to select the brightest and best young men in the service for this work. Something more than mechanical ability is required in a position of this character. First of all the man must be unbiased in his opinion, and imbued with a spirit of honesty. He must be able and willing to defend the rights of the men as well as the interests of the company. It is a part of his business to study the disposition and ability of the men on the different classes of work, recommend to the general foreman changes among the workmen, which in his opinion will increase the earnings of each and also enlarge the output; study facilities, the shapes and angles of cutting tools, feeds and speeds of machines, etc. He can make himself the busiest and most useful official in the entire shop organization from an economical view, and ought to be a man of even temperament, good physique and untiring energy.

The piece-work checkers in the different departments of the shops each perform exactly the same duties, which, briefly stated, consist in carefully checking over the time and work of each employe who is paid by the piece. We depend largely, but not entirly, on these checkers to see that accurate division is made between day and piece-work time, and that the labor on the number of operations turned in by each workman is actually and accurately done. They report to the assistant to general foreman all inaccuracies of every description that may arise in the practical application of the schedules, also all operations in their respective departments having no piece-work price which are of frequent recurrence. These checkers are held responsible by the general foreman for the record of all operations appearing on card, Fig. 3, the use of which will be explained further on.

The master mechanic and general foreman of each shop have the same general control over all the details of piece-work that they exercise over the shop in general. The master mechanic is held responsible for the output of his plant and reports to the assistant mechanical superintendent in charge of shop operations on all matters pertaining to shop machinery and output, and to the shop specialist on all matters pertaining strictly to piece-work and piece-work prices.

The time-keeping department varies but little from that of the ordinary day-work shop, the only practical difference being that, instead of keeping all straight day-work time, the same clerks keep part day-work and part piece-work time. No increase in the time-keeping force is necessary in any shop on account of the introduction of piece-work.

In working out the above organization we have tried in each particular instance to recognize the responsibility resting upon each person placed in charge of a certain line of the work, and the results obtained so far have greatly exceeded our expectations. We have stimulated activity among our piece-work checkers and time specialists by a graduated scale

Schedule No. ______ **ERIE RAILROAD COMPANY** † Form 2105—6, 1905—1m.

RECORD OF OPERATIONS FOR ESTABLISHING PIECE WORK PRICES.

SHOP	DATE	CARD NUMBER	PATERN NO. OR SHAPE NUMBER	CLASS ENGINE OR CAR

MACHINE	SHOP NO.	TOOL STEEL	MATERIAL	

DESCRIPTION OF OPERATION:

TIME SETTING	TIME MACHINING	TIME REMOVING	TOTAL TIME	ROUGHING CUTS			
				SPEED	FEED	DEPTH	NO

FINISH CUT		NO. OF PIECES	OPERATIVE	RATE	COST PER PIECE	PRICE RECOMMENDED
SPEED	FEED					

______ *Piece Work Inspector or Foreman.* ______ *General Foreman*

Remarks: ______

Approved.

Master Mechanic. *Shop Specialist.* *Asst. Mech. Supt.* *Mech. Supt.*

ISSUE ______

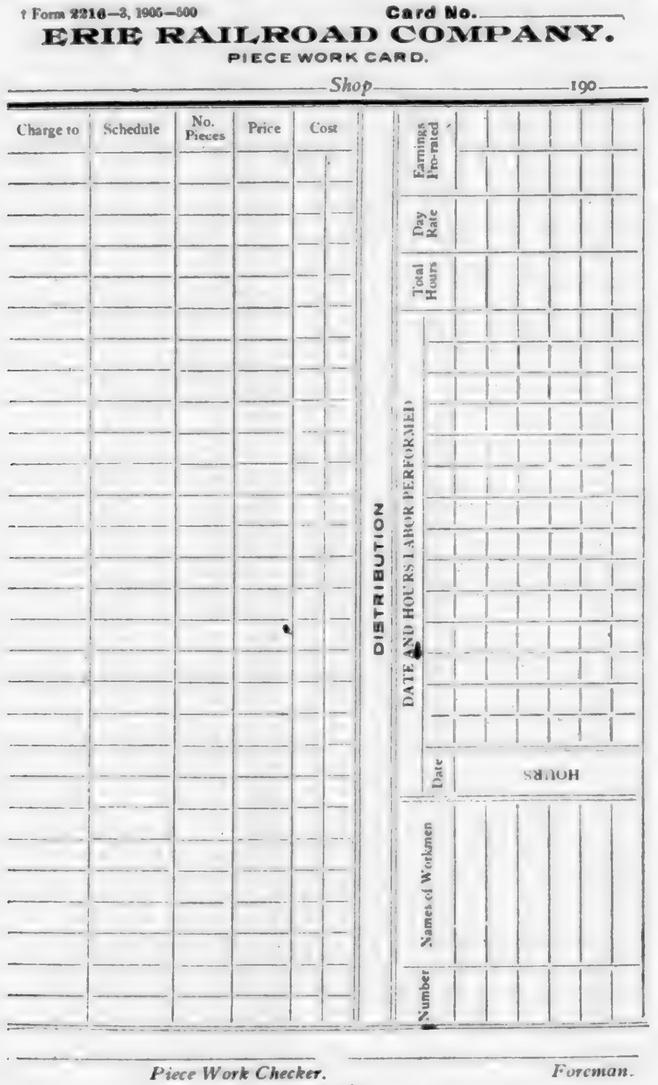
Fig. 2. (Size 6x9 in.)

FIG. 2.

of wages; that is, we recognize the fact that responsibility rests on some positions more than others, and we pay accordingly for the same.

We also pay a little more for positions in the large shops than we do for corresponding work in the small shops, and the young men filling these positions in the small plants understand that promotion to the large shops is sure, provided they are attentive to their work and honest in the performance of their duty both to men and management.

We are unalterably opposed to any organization that divides responsibility. If there is a dividing line between the piece-work officials and the organization responsible for the output, an absence of harmony will exist between the two forces and the production of the shop will be limited. If the


† Form 2216—3, 1905—500 Card No.

ERIE RAILROAD COMPANY.

PIECE WORK CARD.

Shop 190

Charge to | Schedule | No. Pieces | Price | Cost

DISTRIBUTION

Earnings Pro-rated

Day Rate

Total Hours

DATE AND HOURS LABOR PERFORMED

Date | HOURS

Names of Workmen

Number

Piece Work Checker. Foreman.

FIG. 3.

master mechanic or shop superintendent is held responsible for the output of his plant, then he should have control of the means by which that output is secured. When the officials responsible for shop production "hire" the mechanics, and the piece-work department "fires" them because in their opinion they do not quite come up to the standard, there will be more or less friction, all of which the company finally pays for in loss of production.

The card, form 2351, Fig. 1, used by the assistant to the general foreman in timing operations, calls for all the essential information necessary in rate fixing, and is 4 by 6½ ins., a convenient size for the pocket. The assistant to general foreman is instructed to note anything which would in any way affect the price, whether called for by the card or not, and this he does, either under the head of "remarks" or on the back of the card. As these cards are made out, they pass through the hands of the general foreman, and, if satisfactory to him, are turned over to the typewriter, who in turn makes out, in duplicate, card form 2195, Fig. 2. These cards are then signed by the shop officials, as indicated thereon, and sent in to the general office of the mechanical department, where they are checked and signed by the shop specialist, the assistant mechanical superintendent, and approved by the mechanical superintendent. After these cards are approved by the mechanical superintendent they are turned back to the office of the shop specialist and entered in the piece-work schedules (See Fig. 5), the schedule number placed in the upper left-hand corner (See Fig. 2), the original card filed in the file case and the duplicate returned to the master mechanic as his authority to put the price into effect. When the duplicate is received by the master mechanic it is entered in the schedule opposite the schedule number which it bears (See Fig. 2, upper left-hand corner) and filed in a case exactly like the one in the office of the shop specialist.

The piece-work record card (Fig. 3) is used by the piece-work checkers in all departments of the shop in making a record of the operation and time of all piece-workers. A record is made each day of the piece-work completed by each workman, and when the cards are full of items, or a certain amount of work is completed, they are totalled by the piece-work checker, properly signed and turned in to the general foreman's office, from which place they are sent to the time-keeping department.

The daily record cards (Fig. 4) are for the use of the workmen. They are delivered to the employees as they enter on duty in the morning, who make a record of their day's work and deposit same in box at night. Changes from day work to piece-work, or vice versa, are recorded on these cards by the gang foreman in charge of the workmen. When these cards have been checked in the general foreman's office they are turned in to the time-keeping department and checked against the piece-work cards (Fig. 3), to see what differences, if any, exist in the two records.

The piece-work schedules (Fig. 5) are all made up in the office of the shop specialist and sent out to the master mechanic to be put into effect. They are bound in Shipman's cloth binders and form a very neat book. These schedules are put in the hands of the checkers and gang foreman and otherwise distributed about the shop so that the workmen and all concerned can have free access to them.

We attribute the marked degree of success which has rewarded our efforts in the extension of the piece-work principle to the different shops of the Erie Railroad system within the past fourteen months to the perfectly free, honorable and open way in which we have placed the entire subject before our men. While other roads having shops located in towns with us have been compelled to abandon piece rates, temporarily at least, we are extending the system as rapidly as necessary improvements can be made in our shop facilities to warrant fixing a permanent price.

If, on account of changes in conditions, or for any other reason, it is necessary to alter a rate, the change is made in precisely the way in which new prices are fixed. The time specialist reports all the details of the operation, recommends the necessary change, which is signed by the general foreman, master mechanic, shop specialist, assistant mechanical superintendent, and approved by the mechanical superintendent. After the change is approved by the mechanical superintendent the duplicate card is returned to the master mechanic through the office of the shop specialist, and price in shop schedule is changed to agree with the card. Our men know just what we are doing all the time. Our time specialists have received positive instructions not to time operations for the purpose of fixing piece rates without the workman knowing for what purpose time is being taken. The old way was to get the employee on a "hurry-up" job, take the time in secret, deduct 25 or 30 per cent., and then fix the rate on the remainder—much on the same principle as an Indian would shoot his victim from ambush. Thousands of operations have in the past had piece-rate prices fixed on them by incompetent and irresponsible men, who in many cases

have posed as economical experts, and when they were put into effect one or two results always followed: either the workmen were forced to be dishonest and limit the output, or they were compelled to increase their day rate far beyond what was considered fair and equitable daily earnings by the management. If the men "soldiered" the company lost correspondingly in output; if they earned more than a fair day's pay the rates were cut, and there was dissatisfaction, perhaps a strike, among the entire force.

In the two or three shops of the Erie Railroad which have worked more or less piece-work for several years we have found it necessary within the past year to make changes in the prices on hundreds of different operations. Some were too low, many were too high, and while all may have been right when originally fixed, the marked improvement in tool steels, the introduction of modern machinery, and the change in almost every other condition about our shops has rendered it necessary to make numerous changes in old prices. We do not say to our men that we will not change prices. We do not make promises to-day which we know will be broken to-morrow. What we do say is that we will not change a rate unless we can give a good and sufficient reason for it; and when the rate is changed, it will be so fixed that an honest effort on the part of a competent workman will be rewarded by a substantial increase in earnings over his day rate.

No.________ **ERIE RAILROAD COMPANY.** * Form 2443 A—10, 05—250

*Daily Time Record of*____________ *Shop*____________ *Date*____________ 190

CHARGE	PIECE WORK		DAY WORK		HOURS	DESCRIPTION OF DAY WORK
	COMMENCED	FINISHED	COMMENCED	FINISHED		

FIG. 4. (Size 5 1 2x9 1-2 in.) *Correct:*____________ *Foreman.*

FIG. 4.

Thirty-three per cent of the total earnings of all men employed on general locomotive repairs on the entire road is now on a piece-work basis. In the car department 56 per cent. of the freight and 92 per cent. of passenger repairing is piece-work. Over and above this we also pay piece rates on a large part of the work of our heavy repair gangs in the roundhouses. Our engine wiping is all piece-work. We knock all fires, shovel all cinders, and handle all coal at fixed prices for each separate operation. Since the workmen throughout the different departments in all our shops have become thoroughly familiar with our methods of fixing rates, we have encountered no opposition whatever in the extension of the work, and our inability to rapidly change conditions, cut out bad practices, and install proper tools and facilities for making repairs in the most economical way are now the only obstacles which prevent a more rapid extension of the piece-work principle.

* Form 2288—5,'05—50,000

ERIE RAILROAD COMPANY.

PATTERN OR SHAPE NUMBER	SCHEDULE NUMBER	NAME OF PART AND DESCRIPTION OF OPERATION	PRICE

FIG. 5.

On the machine side of our shops the operations are classified and certain machines do certain kinds of work. Our prices are, therefore, in many instances based on single machines, and if the work is changed to some other machine, we, of course, reserve the right to change the price. Each shop on the system is placed strictly on its own merits. As a whole, the schedules made for one shop are never put into effect in another shop. We do, however, where conditions and day rates are the same, frequently send prices on certain operations that have been carefully and accurately timed in one shop, to other parts of the road to be put into effect after the master mechanic and his official force are satisfied they will meet the requirements.

Men earn a great deal more money in a given time under the piece-work system than they do when working for a fixed hourly rate, and no corporation should attempt the introduction of the piece-work principle unless the management is prepared to see their employees earn increased wages. If the capacity of a blacksmith shop is to be doubled without materially increasing the force, there must be something in it for the man at the forge. On piece rates men are more interested in what they are doing, become more efficient in the application of tools, and are more contented in their positions. No "driving" is necessary. If an employee loafs, he alone, and not his employer, suffers the loss in wages.

The piece-work system properly applied stimulates the ingenuity of the men to devise new appliances for reducing the time in handling the work. It stimulates a friendly rivalry both among the men and foreman in the different departments. It brings into immediate competition the different shops on a railroad system and benefits all alike, because each shop is turning out about the same class of work, and as opportunity is presented to show to each other the cost of details, the foreman responsible for the cost, seeing that another shop is able to produce certain work for much less than it is costing him, will at once determine the reason and apply the proper remedy. It benefits alike the employer and the workman, and any body of competent men must admit, if they are reasonable and fair, that the piece-work system, honestly administered, offers to them greater possibilities for increasing their earnings than any other method of remunerating labor, and that where their time is honestly and faithfully applied in the interest of the concern by which they are employed the reward will be proportionate to the effort.

THIRD-RAIL SERVICE DISCONTINUED.—The third-rail electric cars, which have been running on the New York, New Haven & Hartford Railroad between Hartford and Bristol, Conn., for several years, were taken off July 8 and the track restored to its former use as one of the two lines of a double track for steam trains. This action, it is stated, was taken on account of complaints of the danger of the third rail, and an injunction was issued by the court preventing its operation.

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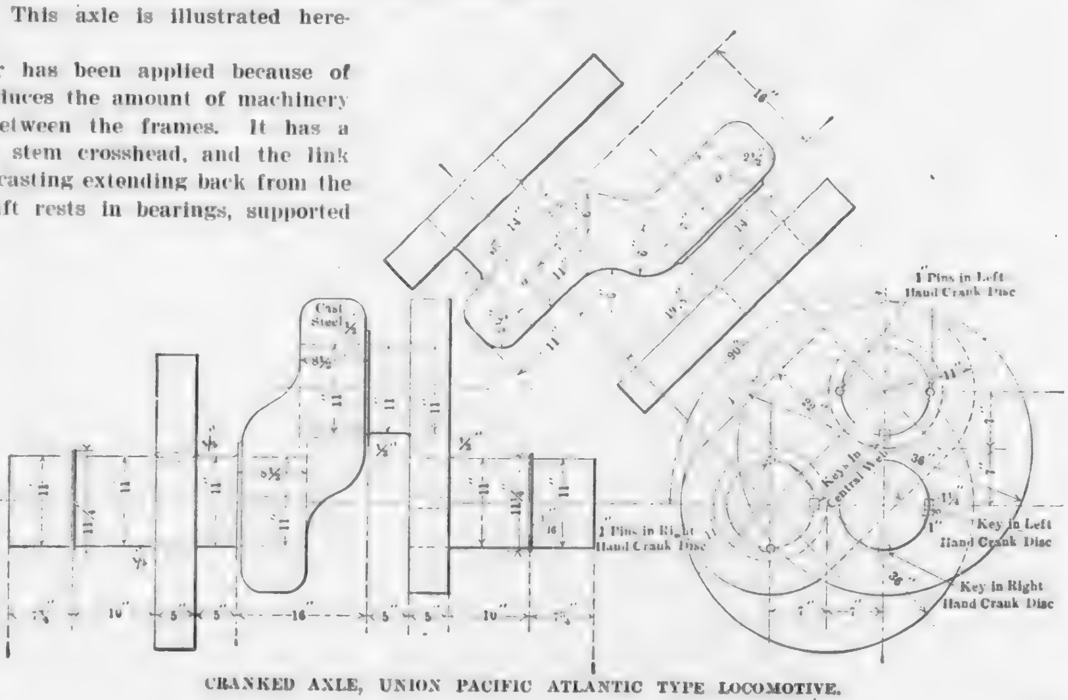

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To the Editor:

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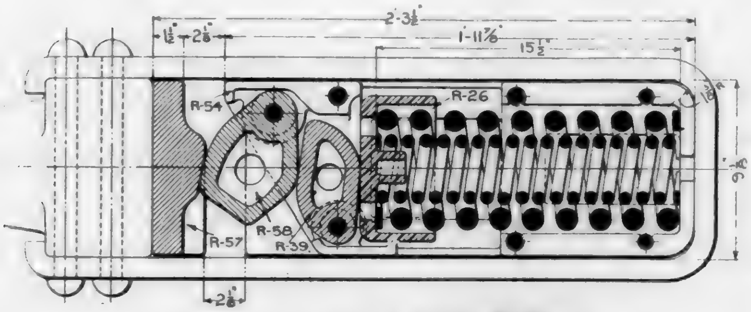

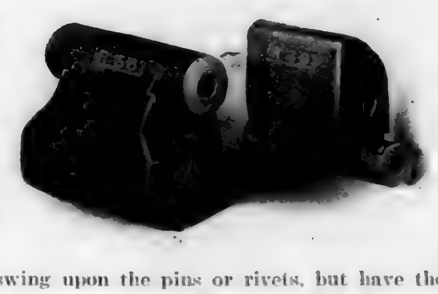

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"They swing upon pins, which, as will be seen by careful examination of the whole gear, carry but little stress, and hence are of light section."

The levers do not swing upon the pins or rivets, but have their bearings and sockets in the malleable iron sides; ¾-in. rivets pass through ⅞-in. holes cored in the levers, but their only office is to hold the two malleable iron sides together.

The enclosed photographs and line drawing clearly illustrate this construction. Morrill Dunn,
Vice-president, McCord & Co.

M. C. B. ASSOCIATION.

TOPICAL DISCUSSIONS.*

Should Not the Uncoupling Chains of Passenger Equipment Be so Arranged as to Guard Against the Uncoupling of Cars in Transit by Passengers Who May Be on the Platform?—Mr. E. F. Chaffee (N. Y. C.), in opening the discussion, described three different arrangements with which he was familiar for uncoupling passenger cars, all of which employed a chain permanently fastened to an upright staff, at the top of which was a wheel or lever on the car platform. The other end of this chain was equipped with a hook for attaching to the coupler locking block. When the chain is not in use it is disconnected from the coupler and hung on an eye-bolt placed under the platform. This method requires the trainman to go between the cars in order to connect the hook to the locking block, and because of that it is considered dangerous. It was suggested that the chain be fastened permanently to the locking block and the hook be arranged to fasten to the crank on the upright staff, which would not require the trainman to go between the cars. Mr. Chaffee recommended a staff with an offset at the bottom, and a drop handle at the top with a chain fastened permanently to the locking block and a hook at the other end, as being a perfectly satisfactory arrangement.

Mr. Curtis (L. & N.) stated that he had placed on passenger cars, in place of the chain, a rod fastened to the locking block and extending out underneath the platform and ending in a handle. This is so arranged as to allow free movement of the coupler, and when it is desired to uncouple, the trainman simply pulls the rod without going between the cars at all. This can be done either from the ground or from the car steps.

Desirability of Adjusting Brake Pressure to Light and Loaded Trains.—Mr. West (N. Y., O. & W.) opened the discussion, and spoke at some length to the effect that it was not necessary or desirable to make arrangements for adjusting brake pressures to light and loaded trains. One reason for this was that the large percentage of air-brake cars now being run in freight trains made this feature of less importance and, judging from the experience with retaining valves, the trainmen could not be depended upon to cut out and in an apparatus for varying the brake pressures. If the air-brake apparatus as applied at present is maintained in a thoroughly efficient manner, there will be sufficient and satisfactory braking power on all trains under usual conditions. Mr. West stated that the maintaining of the condition of the present apparatus should be given more careful attention, before undertaking to apply apparatus to adjust braking pressure to light and loaded cars.

Better Fitting-up of Couplers, Even to the Point of Machining, or at Least Drilling the Pivot Pin Hole Through Coupler Lugs With Knuckle in Place and Tail of Knuckle Forced Against the Lock and Proper Contour Preserved Under This Condition.—Mr. F. W. Brazier (N. Y. C.) opened the discussion, and spoke against the idea of drilling the pin hole with the knuckle in its coupler, since this scheme would tend to individualize the knuckles rather than make them interchangeable. He spoke concerning the strengthening of the different parts which receive the most punishment in service, and stated that with the material at present being used, there was small chance of improvement in that direction, but the better workmanship in the assembling of the parts would probably work an improvement. He believed that the expense of drilling the pin holes in the coupler lugs and knuckles, and also in the coupler shanks for the pocket rivets, would be justified. These, however, should be drilled by jigs and templets, and not by assembling each coupler for drilling.

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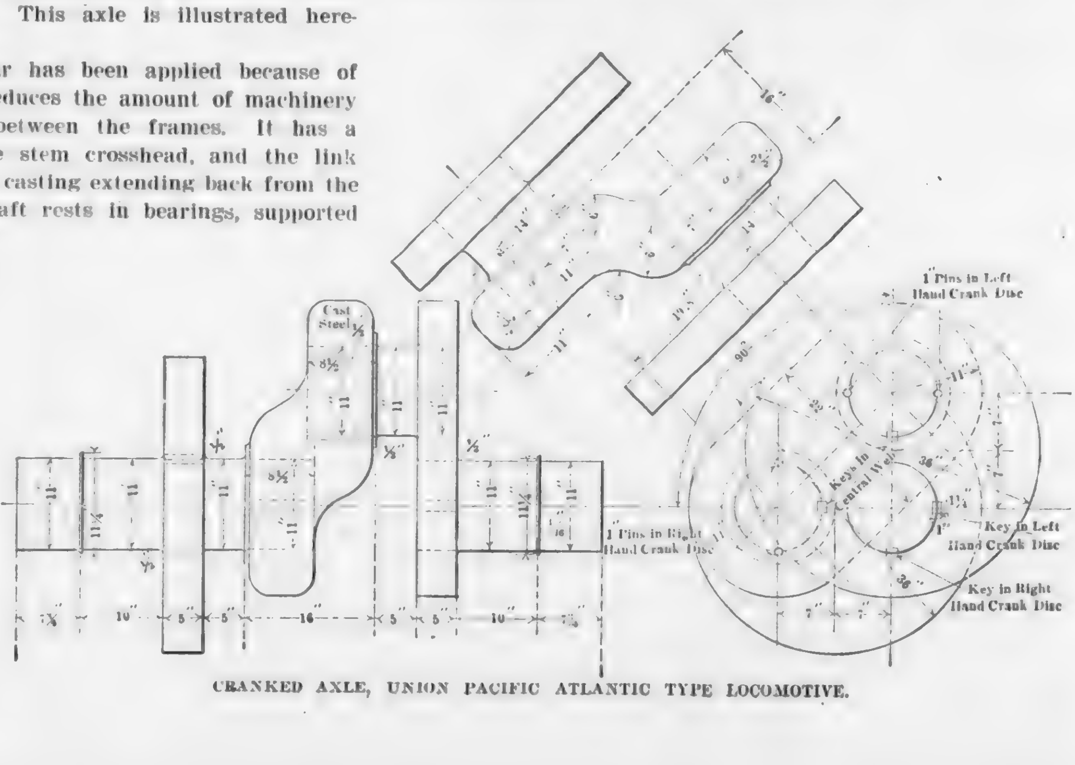

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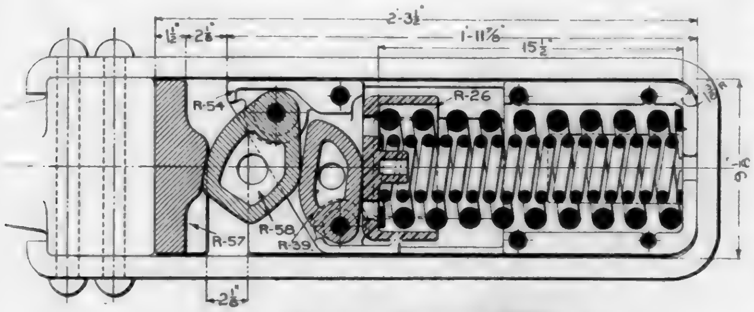

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(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL

PUBLISHED MONTHLY BY

R. M. VAN ARSDALE.

J. S. BONSALL, Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT, E. A. AVERILL, } Editors.

AUGUST, 1906.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

Remit by Express Money Order, Draft or Post Office Order.

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase of construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.*

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The remarks of Dr. W. F. M. Goss at the last Master Mechanics' Convention on the topical discussion, "Is Not a Boiler Pressure of 185 lbs. Better Than 200 lbs. for a Locomotive?" which are given in full on page 311 of this issue, are worthy of more than passing notice. The large amount of time and expense required to keep the modern locomotive boiler carrying 200 lbs. pressure in serviceable condition is easily recognized by not only the motive power department, but also the associated departments, and that relief is desired by all is evident. Many different remedies for this trouble have been tried, some of which have resulted in considerable improvement, but there is still room for further improvement, and Dr. Goss points to a very promising opportunity to obtain it. We trust that his remarks will be given the careful attention that they deserve.

One thing that delays a new shop plant in getting the output for which it is designed is the absence of chucks, jigs, handy devices, etc., for use in connection with the new and improved machinery, which is usually installed. Ordinarily the problem of perfecting the organization when entering new and larger shops is such that little attention can be given to this subject. In order to get the best results it is necessary to have a capable man give his entire time and attention to it, and he should be given the necessary help to assist him in making drawings and the improvements required. The foremen are usually depended upon to get up these devices and improvements in addition to their own work, but the constant interruption and the continual call for their presence in other parts of the shop, as well as the large amount of routine work which they have to handle, prevents them gaining much headway unless it is done out of hours. It is interesting to note that some of the larger shop plants are overcoming this difficulty by placing the matter of care and maintenance of the machine tools and the question of improving their output in the hands of a capable man and giving him sufficient assistance to carry out his ideas. In one large shop this man, who reports directly to the shop superintendent, has two good draughtsmen under him, and in another large plant all the engineering problems connected with the shop maintenance and operation are in charge of a man who reports directly to the shop superintendent and has sufficient help to assist him in carrying out this work and improving the production.

ELECTRIFICATION OF A STEAM RAILROAD.

The first extensive change of the motive power on a surface railroad from steam locomotives to electricity is being made by the Long Island Railroad Company, which is now running a considerable number of electric trains, and is increasing the number as rapidly as possible. It is expected that within a very short time all lines where the traffic is of sufficient density will be electrified, and steam locomotives will be used only where an infrequent train service is required.

This railroad occupies a unique position as compared with other steam railroads, in that the traffic is so predominantly passenger, the passenger train mileage being about eight times the freight train mileage, where ordinarily the two are equal. This, coupled with the fact that the density of passenger traffic on this road is enormous, being nearly 47,000 passengers carried per mile of track as compared with about 6,000 for the whole of New York State, including the Long Island Railroad, and about 2,500 for the whole country. Also, the average haul per passenger (about 14½ miles) is less than half the average for the whole country and 50 per cent. less than the average for New York State. These facts show conditions which are particularly well adapted for the advantages of electric traction. However, taken together, the conditions presented here are not incomparable with the strictly suburban sections of many other railroads, and what has been done by the Long Island is interesting as illustrating one method of solving a problem which several companies will soon have to face.

In the May issue of this journal appeared a very complete description of the large power house which furnishes the current for operating the trains, and elsewhere in this issue is given a brief general description of the transmission line and sub-stations. Our next issue will contain an illustrated article on the all-steel passenger cars being operated over the electrified portions of the road.

MASTER MECHANICS' ASSOCIATION.

39TH ANNUAL CONVENTION.

TOPICAL DISCUSSIONS.*

IS NOT A BOILER PRESSURE OF 185 LBS. BETTER THAN 200 LBS. FOR LOCOMOTIVES?—Dr. W. F. M. Goss opened this subject as follows: "I assume that the question which is asked applies to simple locomotives using saturated steam; also that the question applies to proposed locomotives; that is, that I may discuss it as a question of design rather than a question of expediency controlling the operation of existing engines. Since the beginning of practice involving locomotives the steam pressure has steadily increased. I have taken from a paper by Mr. William Forsyth, published some time ago in the *Engineering Magazine*, a diagram showing the progress in steam pressure, with the years. On this diagram the 100-lb. limit was passed between 1860 and 1870; the 160-lb. limit was passed in 1890; the 200-lb. limit was exceeded in certain cases in 1900, and the tendency of the curve is still upward. In view of this history it is of importance to ask whether the limit of pressure has been reached; or, to word the question as it has been worded for me, as to whether the limit has not already been passed. As a preliminary to a more detailed discussion of the subject, I would call attention to the fact that as a problem in design the question of steam pressure does not directly affect the question of power. It is a common mistake to assume that a locomotive carrying an abnormally high steam pressure must be abnormally powerful. Of course, those of you who have studied the problem understand that that need not be so, since the power which the locomotive develops is represented by the stresses which are transmitted by the piston rods, and these stresses are as much a function of the cylinder volume as of the steam pressure. Consequently, having selected our steam pressure, we may determine the volume of cylinders for any power which is within the capacity of the other proportions of the locomotive. The thing which I emphasize is, then, that the question of power is not related to that of pressure as a problem in design, except in so far as pressure may effect efficiency."

"This leads us, then, to a consideration of the question: to what extent will increase in pressure improve the cylinder performance of a locomotive? I believe that a general view of the facts involved in this question may most easily be apprehended by referring to the performance of the ideally perfect engine, and for this reason I have given upon Diagram 2 as the curve A B the steam consumption per horse-power hour of an engine ideally perfect, using steam at various pressures and exhausting at a pressure of 5 lbs. above atmosphere. From this diagram you will see that beginning with a pressure of 25 lbs. the steam consumption per hourse-power hour of this perfect engine is 40 lbs., and that the steam consumption diminishes rapidly as the pressure is increased until the pressures become considerable. For the higher ranges of pressure the increase in performance is very slight. For example, if you will scan the upper portion of that curve you will note that from 175 lbs. to 275 lbs. the inclination of the line is very slight. The performance at the higher pressure is but slightly better than that at 175 lbs. From this statement it appears that from theoretical considerations alone we should not expect any large improvement in the efficiency of the locomotive by merely increasing pressure."

"Turning now to an experimental side of the question, and considering what the actual performance of a locomotive may be when served with pressures of different values, I present to you the line C D, which fairly represents a series of more than 70 tests, all under pressures ranging from 120 to 250 lbs. per sq. in., and which have been conducted under the patronage of the Carnegie Institution. This curve C D fairly represents these 70 tests, showing the steam consumption per horse-power hour for the several pressures given. I call your attention also to the form of this curve. Its upper portion you will see is almost vertical. The change in performance when the pressure is increased from 175 lbs. to 250 lbs. amounts only to 1.3 lbs. of steam per horse-power hour. Moreover, I would add that these curves are plotted as shown, in terms of steam per horse-power hour, inasmuch as at the higher pressures a pound of steam represents more heat than

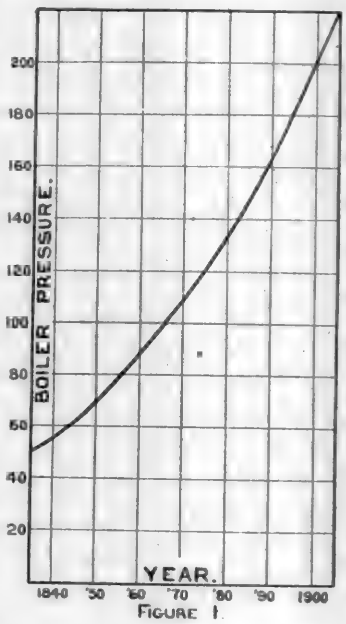


FIGURE 1

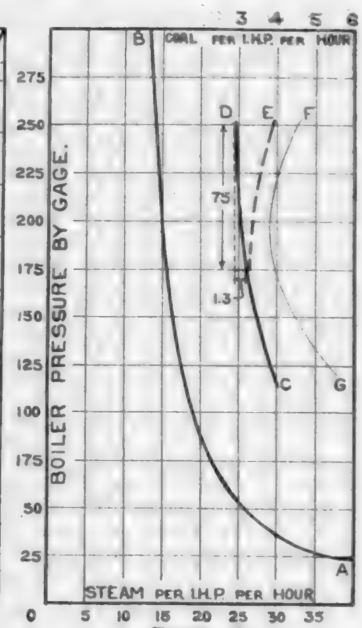


FIGURE 2

at the lower pressure. If the plottings were made upon a heat basis alone, these lines would be even more nearly vertical than they are shown."

"The results which are represented by line C D are obtained in return for great vigilance in the maintenance of boiler and engine. Small leaks occur, especially at the higher pressures, which, while they may attract but little attention, become the source of serious losses. These leaks and the effect which they have upon cylinder performance are more difficult to deal with as the range of pressure increases, so that if we take an actual engine working under conditions of service, the actual performance, as measured by steam per horse-power hour, is likely to take some other curve; not the curve C D, but some curve which may be C E. That is, the expected gain when the pressure is increased actually becomes a loss through incidental causes, chiefly through leaks."

"Of course, the problem of coal consumption per horse-power hour is, after all, that which we are after. I cannot present to you any curve of coal consumption which will be as representative as that which I have given for steam consumption, since the data covering coal performance is not yet in hand; but I do present to you a curve which I have lettered F G, which represents one series of tests. All the tests which were made were made with a given cut-off, about ¼ stroke—perhaps 15 or 18 tests altogether—and you will note that on the basis of coal consumption as determined from these few tests we have the minimum consumption at a pressure not greater, at any rate, than 200 lbs., and when the pressure is increased above that limit the coal consumption increases. The values to which the curve F G refers are given at the top of the diagram."

"This presents to you in rather brief form the performance of a single actual engine as regards cylinder performance and coal consumption. I must call your attention to the fact that this is not a fair and full statement of all of the problems involved, because of the fact that the tests here were run at comparatively low pressures, with a boiler which was designed for 250 lbs. pressure. That is, it was lower than a high-pressure boiler."

"Suppose, now, instead of proceeding, as has been done with these experiments, there had been a new boiler available for

*Continued from last month

each of these different pressures, which boilers would be constant in weight, but those which were designed for low pressures would be made enough larger in their heating surface to maintain their weight; that is, suppose in this record we had taken advantage of the opportunities which the selection of lower pressure would give for increasing the size of the boiler. It would then appear that all of these lines would show a lower steam consumption and a lower coal consumption, as we go downward. That is, the upper end of these lines would at once move to the right, showing that the point of minimum consumption would be lower than the points which are shown by them, and as a problem in design, of course, it is that view which must in the end prevail."

"Summarizing the statements already made, and adding others thereto, the following will be found to be true:

(1) Very high steam pressures are not essential to the development of high power.

(2) The advantages to be obtained from an increase of pressure above any given limit are only such as may be derived from an improvement in cylinder performance, and from a reduction in the dimensions of cylinders. For all increments of pressure above 150 lbs., the possible improvement in cylinder performance will be small; above 185 lbs. it is practically negligible. As to cylinders, it may be noted that conditions external to the locomotive may sometimes require the use of abnormally small cylinders, but such conditions will not often be a controlling factor. It is true also that small cylinders permit the use of lighter pistons, and hence they tend to simplify the problem of counterbalancing."

(3) The disadvantages to be met when the pressure is increased above any given limit are as follows:

(a) An increased weight of boiler for a given amount of heating surface; or when the designer is required to observe weight limits, less heating surface than might otherwise be used, and hence a boiler of lower efficiency.

(b) Where feed water is of poor quality it increases the difficulty attending the maintenance in working condition of injectors and boiler checks.

(c) It complicates the problem of keeping boilers tight and in general adds enormously to the cost of boiler maintenance.

(d) It increases incidental losses, especially those occurring in the form of leaks of steam or water from boiler and cylinders."

"From these considerations it appears that a general solution of the problem of determining what is the most economical pressure for a locomotive involves three sets of facts:

(1) Those defining cylinder and boiler performance. (2) Those dealing with the weight of boilers designed for different pressures and different capacities. (3) The degree of perfection with which the locomotives are to be maintained in service."

"An abundance of data covering the first two of these points is now in hand, while the third probably can never be absolutely defined."

"I may say that during the summer it is expected that an analysis based upon this data to which I have referred will be made, and I am hoping that by fall I shall be able to add to this discussion something that will be more conclusive than that which I give now. Meantime, I can only say, in response to the specific question which has been assigned me, that my investigations justify the assertion that a pressure of 185 lbs. will give better results in a simple locomotive using saturated steam than would be obtained from a pressure of 200 lbs."

The Necessity of Proportioning Brake Pressures to Wheel Loads.—Mr. George L. Fowler opened this discussion, and mentioned the fact that the M. C. B. Association had expressed itself as being opposed to changing the brake pressure in light and loaded cars. This action he considered to apply to ordinary merchandise service under present conditions. He thought, however, since a car of 110,000 lbs. capacity with the present arrangement was braked to only about 17 per cent. of its weight, that certain cars in special service could be advantageously fitted with an arrangement for increasing the brake pressure when the car was loaded. In case such an arrangement was automatic it would be better to have it operate in only one direction; that is, to have it cut out when the car was light. He considered that for coal or ore trains, and possibly cattle trains running in regular service, such a device would be exceedingly valuable. This could be cut in when the car was loaded at the terminal, and would be automatically cut out when it was empty.

The Distortion of Wheel Centers and Tires Out of Round, Due to Heavy Counterbalance on 100-ton Engines.—Mr. George W. West opened the discussion, and spoke of his experience with some 100-ton engines which were very satisfactory riding locomotives until the tires had worn down to about 2¼ ins. thick, when they began to ride very hard, due to the tires being out of round. Later it was found in attempting to apply tires to the same wheel centers, which were of cast steel, without truing them up, that the centers were also out of round. It was found, upon testing, that the wheel was compressed between the counterbalance and the hub from 1-32 to 3-32 of an inch. He thought this to be due to poor design.

To What Extent Should an Engine Be Repaired in the Main Shop, and What Class of Repairs Could Be Made to Advantage in the Roundhouse?—Mr. C. A. Seley stated that it was a general custom when engines go into the main shop for general repairs to completely dismantle them. He did not think that this was always necessary, and that there were certain parts in a locomotive which could better remain as they were, mentioning as examples the injector, cylinder lubricator, cocks and valves in the cab, pumps, cylinder and valve packing. These parts are in most cases maintained in satisfactory shape by the roundhouse forces, and it is not necessary to take them down in the main shop. He considers that a large saving could be made by close attention in the shop, so that no unnecessary work would be done.

Mr. G. R. Henderson spoke of the card system, by which each engine is assigned a card when it goes to the shop, on which the cost of repairs and their general nature is stated in detail. This card was filed, and the next time the engine was sent to the shop the card giving an account of what repairs had previously been made, which compared with the mileage the engine had made since that shopping, gave indication of what work would be required.

Relative Advantage of a Piston Valve as Compared to a Slide Valve.—Mr. E. A. Miller (N. Y. C. & St. L.) opened the discussion, and gave the results of quite a large number of tests made to show the difference in leakage past the rings of slide and piston valves. Some of these tests showed that the slide valves caused more leakage. The general conclusion which he drew, however, from the different series of tests was that the piston valve gave more leakage than a balanced slide valve.

Mr. William McIntosh stated his experience to the effect that piston valves would need careful attention and occasional refitting, in order to prevent excessive leakage.

Mr. J. F. Walsh stated that he had applied piston valves to a large number of engines, principally on account of the easier handling in switching. He stated that his piston valve engines had given little trouble from leakage or in other respects, and that he thought there was so much in favor of the piston valve as against the D valve that there is but little room for argument as to which is best.

Mr. John Player called attention to the fact that because of the increased length of the ports in a piston valve engine, the comparative measure of the leakage should not be taken as the measure of the efficiency of the valve.

Mr. John H. Pilcher (N. & W.) stated that, while the tests quoted from his road showed that the piston valve leaked less than the slide valve, that experiments on the road would seem to indicate otherwise; they were, however, applying piston valves to new power.

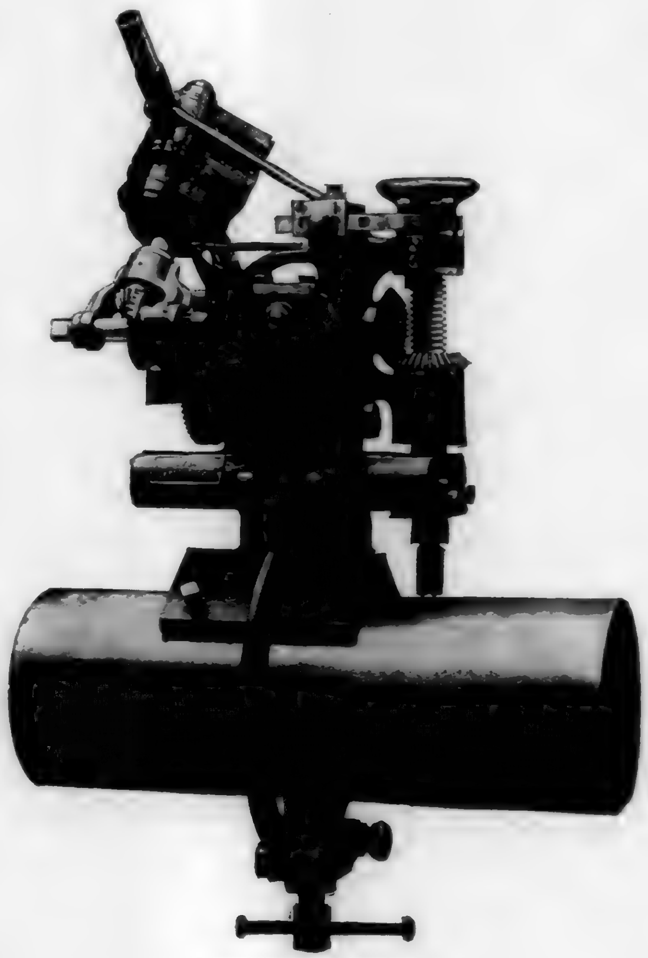
Mr. S. T. Parks (M. C.) brought up the point of the engineer not being able to tell if the piston valve was being properly lubricated, and recounted some tests which he had made, showing that a dry piston valve gave practicaally no indication upon the reverse lever.

PORTABLE KEY-SEATING MACHINE.

A light-weight machine which will automatically mill the key-seat in a locomotive driving axle or a shop line shaft has recently been placed upon the market by Joseph T. Ryerson & Son, Chicago. This machine, which is illustrated herewith, is driven by a small size air motor, which, through the proper gearing, operates a milling cutter for milling the key-seat. It is so arranged that it can be set for any desired length and depth of seat, and will work automatically. The construction is substantial, but so carefully designed that the whole machine weighs but 100 lbs., and can be easily located and set by one man.

This machine is particularly adapted for milling key-ways in driving axles after the locomotive is assembled, and is so constructed that it can mill a key-way to within one inch of the driving box. It has a particular field of usefulness in milling new key-ways in axles after a locomotive has been repaired and changes made in the location of the eccentrics, such as ordinarily require the use of an offset key, which is objectionable from all points of view. It will, we believe, cover a field which has long been a source of annoyance and delay to master mechanics.

One of these machines was shown in operation at the Atlantic City conventions by the manufacturers, where it illustrated its capabilities very clearly.



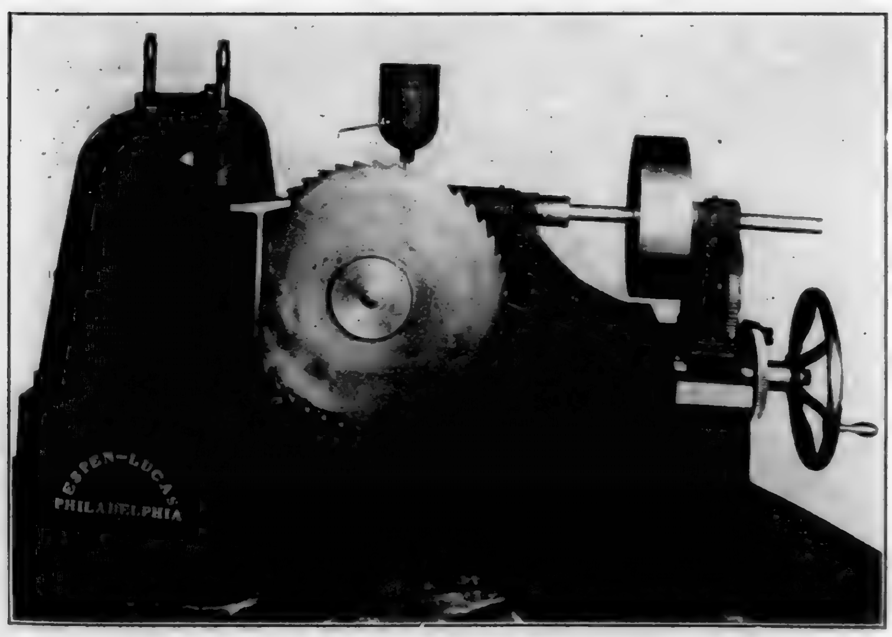
KEY-SEATING MACHINE.

ESPEN-LUCAS COLD SAWS.

A cold saw cutting-off machine, which has a capacity for cutting structural material up to 20-in. I beams, has recently been placed on the market by the Espen-Lucas Machine Works, Broad and Noble streets, Philadelphia, and is illustrated herewith.

This machine has two swiveled clamps for holding the work which can be adjusted to hold the beam or other material to be cut, either at an angle, as shown in the illustration, or for a straight cut, in which case both clamps are on the same side of the work and spaced suitably to hold both sections of the cut beam. The saw blade, which can be either the solid blade or with high-speed steel inserted teeth, is driven through a worm gear from a belt connection. The worm is of hardened crucible steel and the worm wheel of phosphor bronze. The heavy gears for driving the saw are of hammered crucible steel cut from the solid. The feed is variable and automatic, and can be increased or decreased as desired while the machine is cutting. An automatic stop is provided for throwing out the feed at any desired depth of cut.

The capacity of the machine illustrated is 20-in. I beams or 9-in. solid bars, and the floor space occupied is 40 by 80 ins. The machine weighs 7,000 lbs.



ESPEN-LUCAS COLD SAW.

Excellent Record of the Pennsylvania Special.—The record for the first year's service of the 18-hour "Pennsylvania Special" between New York and Chicago, which began running on June 11th, 1905, is now at hand, and shows that during the 365 days' service this train arrived late at Jersey City but 54 times and at Chicago but 37 times. The equipment of the train caused delay 17 times during the year to the eastbound train and 14 times to the westbound train. The remainder of the delays were due to various road causes.

Traveling Engineers' Association.—The fourteenth annual convention of this association will be held at the Auditorium Hotel, Chicago, commencing on August 28, and will probably continue over four days. W. O. Thompson, Oswego, N. Y., is secretary.

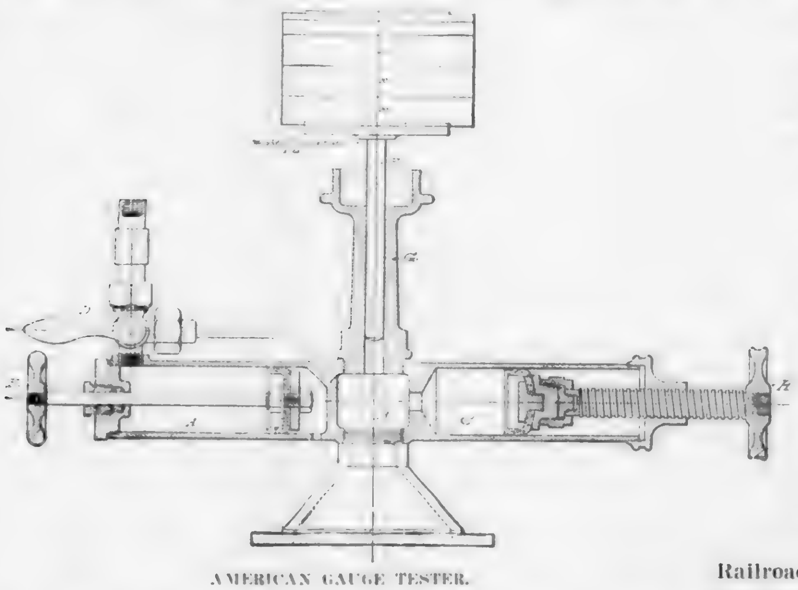
AMERICAN DEAD WEIGHT TESTER.

The necessity for having accurate and reliable apparatus for checking and testing pressure gauges is easily recognized. The common method of having a test gauge, which it is necessary to have checked by an absolutely accurate pressure test at various times in order to insure its reliability, has its disadvantages, and to overcome such objections the American Steam Gauge & Valve Manufacturing Company, Boston, Mass., has recently put on the market a dead weight tester for pressure gauges which can be relied upon for absolute accuracy at all times and does not require checking by any other apparatus.

This dead weight tester is shown in section herewith, and it can be seen that the pressure upon the gauge is obtained by the actual pressure given by weights, and hence is positive and accurate. The instrument is made in very compact and convenient form, and is constructed with the idea of convenience and simplicity as well as accuracy.

The principal parts of the apparatus are a chamber B, which is directly connected to the cylinder G, in which a small piston, F, operates. The area of this piston is very carefully figured, and the weights placed on the stand above are of the proper weight to give the pressure per square inch marked on them. The gauge is also connected to this chamber through a short section of piping, which passes through a three-way valve on its way to the gauge. The chamber, A, which has no direct connection with B, is used as an oil reservoir for storing the oil required to fill the connection between the valve and the gauge. It has a plunger operated by a handle. The chamber C has a screw plunger, whose office is to raise the piston F under weight after the gauge is in place. The whole apparatus is mounted on a wooden base, and is polished and finished in a suitable manner.

The operation of the tester is as follows: After the chambers A, B and C are filled with a light mineral oil, and the gauge to be tested is screwed in place, the handle of the three-way cock D is turned to give connection to the chamber



AMERICAN GAUGE TESTER.

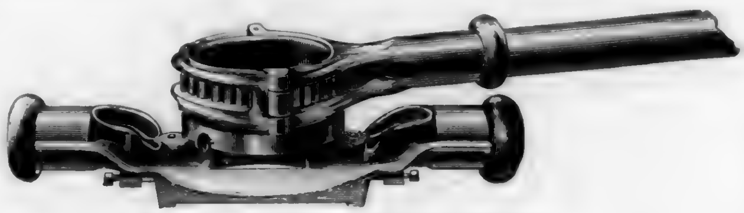
A, then the plunger E is pulled outward until the gauge shows some pressure indicating that the connections are filled with oil. The three-way cock D is then turned, closing the connection to chamber A and opening it to chamber B. The weights corresponding to the pressure desired, less 5 lbs. furnished by the stand and piston, are placed on the stand, and the screw plunger in C is forced inward until the pressure acting on the piston F raises the weights, at which time the gauge will, if properly adjusted, show the pressure indicated by the weights. The screw plunger can be turned so as to raise the weight piston up and down, thus eliminating any chance of error by its sticking in the cylinder.

After testing and before disconnecting the gauge the handle E is pushed inward and the three-way cock D turned to allow the oil from the gauge connections to be collected in the chamber A, thus preventing the loss of any oil during the testing.

A RATCHET ATTACHMENT FOR DIE STOCKS.

The frequent necessity for doing pipe work and for making alterations and repairs to piping in close and cramped quarters has brought several ratchet die stocks on the market. These usually require that the buyer purchase a complete stock in order to avail himself of the ratchet.

The Armstrong Manufacturing Company, Bridgeport, Conn., however, recently perfected ratchet attachments fitting their various sizes of stocks, which are easily attached to or removed from the stock by simply removing a thumb screw.



RATCHET ATTACHMENT FOR DIE STOCKS.

This allows the pipe-fitter to use the regular Armstrong stock on ordinary work, and have only the added weight of the ratchet, in cases where it is necessary to thread the pipe in confined space, such as in ditches or where the pipe runs near a wall or ceiling.

The Armstrong ratchet consists in a light but strong malleable iron ring, which carries the ratchet and pawl, and which is slipped over the barrel of the stock and securely attached to it by a thumb screw. No extra handle is provided as the extension is tapped to receive one of the stock handles. It may be adjusted for turning the stock in either direction.

This is a strong and thoroughly reliable tool that has proved of great service and value to pipe fitters and engineers, enabling them to use regular Armstrong stocks for threading pipe in positions where otherwise they would have to take down the pipe.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—The fourteenth annual convention of this association will be held at the Sherman House, Chicago, commencing on August 21, and will be in session for three days. Committee reports on the following subjects will be presented and discussed: "Frogs and Crossings," S. Uren, chairman; "Flue Welding—Best Method of Flue Welding and Flue Used," G. H. Judy, chairman; "Classification of Work in Shop," W. J. Mayer, chairman; "Tools and Formers for Bulldozers, Steam Hammers and Forging Machines," Thomas F. Keane, chairman; "Discipline, and How to Obtain the Best Results in a Railroad Blacksmith Shop," A. W. McCaslin, chairman; "Case Hardening Methods—Time Taken and Specimens of Work Furnished, and Kind of Material Used," G. F. Hinkins, chairman; "Best Method of Annealing High-Speed Steel, Also of Tempering," George Lindsay, chairman; "Best Coal for Use in Smith Shop and Kind of Fires Used," John Buckley, chairman; "Subjects for 1907 Meeting," G. H. Judy, chairman; "Piece Work vs. Day Work," R. A. Mould, chairman; "Making of Locomotive Frames—From Scrap to Finish, Also Repairing—How Many Broken During the Year—How Often Broken in Same Place," James Fenwick, chairman; "Thermit Welding and Cost," George Kelly, chairman. All motive power officials and foremen blacksmiths are cordially invited to attend, whether members of the Association or not.

MASTER CAR BUILDER'S ASSOCIATION.

ABSTRACTS OF REPORTS.

(*Continued from page* 288.)

CAST IRON WHEELS.

Committee.—Wm. Garstang, Chairman; A. S. Vogt, H. J. Small, W. E. Fowler, R. L. Ettinger, J. J. Hennessey, J. E. Muhlfeld.

As instructed, we were able to arrange a conference with the American Railway Association, through a committee appointed by President Fish, with Mr. G. L. Peck as chairman, the instructions to Mr. Peck's committee being to consider a standard cast iron wheel and rail section. The personnel of this committee was as follows: Mr. J. T. Richards, C. E., Pennsylvania Railroad; Mr. J. Kruttschnitt, director of maintenance and operation, Southern Pacific; W. J. Wilgus, vice-president, New York Central; R. Montford, consulting engineer, Louisville & Nashville; E. C. Carter, C. E., Chicago & Northwestern; William Garstang, superintendent motive power, Big Four; R. L. Ettenger, consulting mechanical engineer, Southern; W. E. Fowler, master car builder, Canadian Pacific.

This committee held a meeting on April 24 at Chicago, and another meeting on June 12, at Atlantic City. At the Chicago meeting, the present Master Car Builders' standard wheel was presented with the flange increased ⅛ in. on the inside.

The maintenance of way members, after taking the matter under advisement, reported at the Atlantic City meeting that the thickness of flange might be used with present track conditions without detriment to frogs or crossings, and to put the opinion of his committee before the Master Car Builders' Association, so that some action can be taken at this convention, Mr. G. L. Peck, chairman, has handed us the following letter:

"The question as to whether the proposed increase of ⅛ in. in the thickness of flange of cast iron wheel would make it necessary to increase the clearance at frogs and guard rails, was considered by the committee on Standard Rail and Wheel Sections of the American Railway Association, at its meeting in Atlantic City to-day.

"The committee decided unanimously that a wheel of the section submitted by your committee could be run through the present clearances without difficulty, for, while the increase in thickness amounts to ⅛ in. at the point where you measure the flange, we find that the increased thickness at the point of gauge for track is not more than 1-32 in., or an amount almost negligible.

"The committee, of course, will not be prepared to adopt or recommend a standard cast iron wheel in all its features until after hearing from the Master Car Builders, but in view of the fact that the flange matter may be considered somewhat of an emergency, the committee will be prepared to recommend an increase in the thickness of the flange to the American Railway Association, so that action may be taken by that body at its meeting in October next.

(Signed) "G. L. PECK, Chairman."

Your committee, therefore, asks that action be taken during this convention that will enable the American Railway Association to have our recommendations before them at their October meeting, and we submit for approval the following changes in the present standard wheel: An increase of ⅛ in. on the flange, and a change in the taper of the tread from one in twenty-five to one in twenty. The reason for asking for the change in the taper is due to experiments that have recently been made which indicate less flange wear and a longer life to the wheel on this account.

We also ask that the specifications be changed so that the minimum weight be 600, 650 and 700 lbs. This is necessary because the increase in the flange will add about 15 lbs. to the present standard wheel. Your committee feels that these are the only changes to recommend in the present wheel, and if allowed, will result in a design that will very largely eliminate flange failures.

Should the action of your committee meet with the approval of the association, we call attention to the necessity of revising the present mounting gauges to suit the increased wheel flange, and would suggest that this be taken up by a committee during the present year.

BRAKE SHOES.

Committee—W. F. M. Goss, chairman; William Garstang, George W. West.

Your standing committee on brake shoes, at a meeting held at Indianapolis October 10, 1905, agreed that some inquiry should be made to ascertain the frictional quality of the shoes now being supplied to railway companies in comparison with the specifications of the Association. To this end, at the request of your committee, a circular was issued by the secretary, requesting the railway companies to submit shoes for tests, shoes submitted to be taken from service after having been approximately one-third worn.

Under this arrangement a total of 109 shoes was received from nine different railway companies, two of the shipments, however, arriving too late to receive attention during the present year. [Of this number 16 representative shoes were tested.]

All shoes received were delivered to the engineering laboratory of Purdue University. The tests were made under the direction of the University, the work being in the immediate charge of Prof. W. O. Teague, who was assisted by Mr. L. E. Endsley, instructor in the engineering laboratory.

It had been requested that each shoe be marked with a statement of the service from which it had been taken. In cases where the accompanying statement showed that the shoe had been taken from freight service, it was tested upon a cast-iron wheel only; where the statement showed that it had been taken from passenger service, it was tested on a steel-tired wheel only, and where no statement as to service accompanied the shoe, it was tested on both cast-iron and steel-tired wheels.

The results disclosed the fact that of the fifteen shoes tested on the cast-iron wheel three completely met the specifications of the Association. Eleven of the fifteen met the specifications as to the mean coefficient of friction, but eight of this number exceeded the limits allowed at the end of the stop. Five shoes met the specifications as to the rise in the coefficient at the end of the stop. Of the nine shoes tested on the steel-tired wheel, all met the specifications as to the mean coefficient of friction during a stop, but all failed to meet the specifications as to rise in the coefficient of friction at the end of the stop.

Your committee would call attention to the fact that while the specifications provide for a minimum coefficient of friction they do not fix a maximum; also to the fact that at least two shoes which were tested possess frictional qualities which are far in excess of the minimum values specified. While a high coefficient of friction is, in the abstract, a desirable characteristic to be possessed by a brake shoe, operating conditions make uniformity of action desirable. For example, the records of the Association show that a large amount of attention has been bestowed upon the triple valve for the purpose of securing uniformity both in time and intensity of its action, that the surging of trains may be prevented. But the retarding force which is set up through the action of the brakes is as much a function of the frictional qualities of the brake shoes as of the action of the triple valve. Assuming all cars of a train to have the same brake leverage, and to be equipped with triple valves possessing identical characteristics, if the frictional qualities of the brake shoe are disregarded, that car which is fitted with shoes developing a high coefficient will tend to stop more quickly than an adjoining car having brake shoes possessing inferior frictional qualities. If variations in the coefficient of friction of brake shoes are allowed to become great, the surging of the several cars making up a train is likely to become severe. The extent of the variation in frictional qualities may best be seen by reference to Appendix I. A brief summary of this Appendix is as follows:

MEAN COEFFICIENT OF FRICTION DEVELOPED UPON A CAST-IRON WHEEL UNDER A BRAKE-SHOE PRESSURE OF 4,152 POUNDS.

Brake-Shoe Number.	Coefficient of Friction.	Coefficient of Friction at a Point 15 Feet from Stop.
Values provided for by the Specifications.	20.	7.
158	20.0	5.2
161	21.6	2.2
163	21.3	7.0
172	20.6	6.9
175	27.2	7.0
178	17.7	6.4
179	33.2	6.3
183	37.4	2.6
186	21.3	8.6
194	22.3	7.6
200	20.3	6.9
205	21.4	7.7
209	23.8	5.5
214	19.3	6.7
220	24.4	7.0

MEAN COEFFICIENT OF FRICTION DEVELOPED UPON A STEEL-TIRED WHEEL UNDER A BRAKE SHOE PRESSURE OF 4152 POUNDS.

Brake-Shoe Number.	Coefficient of Friction.	Coefficient of Friction at a Point 15 Feet from Stop.
Values provided for by the Specifications.	14	7
158	17.0	9.0
161	14.8	10.1
163	18.9	8.8
175	18.4	12.4
178	16.7	9.2
179	22.8	7.8
205	16.3	8.9
209	16.0	11.1
215	16.5	10.8

Thus far the standing committee on brake shoes has concerned itself with the frictional qualities of brake shoes. The question has often been raised as to whether it would not be practicable for your committee to test the wearing qualities of brake shoes. Response to inquiries of this kind has uniformly been made to the effect that the processes of the laboratory proceed too slowly to permit such tests to be made, and those inquiring have been referred to road tests as the readiest means of determining the endurance of shoes. Your committee is, however, convinced that many interests would be served if manufacturers, in submitting shoes for test, could be given a statement covering wearing qualities, as well as a statement covering coefficient of friction. It is also possible that if a satisfactory test could be formulated, specifications covering wearing qualities might be framed.

In its consideration of this matter your committee has reached the conclusion that such tests are possible provided some additional mechanism could be attached to the testing machine. The purpose of the proposed addition to the testing machine would be to permit a shoe to be brought in contact with the wheel of the testing machine for a predetermined interval, after which it would be automatically raised from the wheel and remain in released position

for another and a much longer interval, after which it would again automatically make contact with the wheel. It is believed that by such a cycle any shoe could be given a definite amount of exposure to wear, and that by the automatic action of the machine in alternately making the application and release all chances of excessive heating would be avoided.

In following up the matter your committee was fortunate in securing the interest and assistance of Mr. Fritz Ernest, instructor in car and locomotive design, Purdue University, who undertook a study of the problem, with the result that the details of a satisfactory mechanism have been designed. A description and drawings of the proposed mechanism are given as Appendix II. The cost of making the proposed additions will be between $300 and $400.

Among others who have given assistance in the work of the year your committee would especially acknowledge the courtesy of the Griffin Wheel Company in supplying for the brake-shoe testing machine three specially bored and fitted cast-iron wheels.

In conclusion, to summarize its report, your committee would call attention to the following matters:

1. That shoes taken from service have in most cases met the requirements of the Association with reference to the mean coefficient of friction to be developed during a stop.

2. That shoes taken from service have in most cases failed to meet the requirements of the Association with reference to the rise in the coefficient of friction at a point 15 feet from the end of the stop.

3. That shoes are now in service which give a coefficient of friction so much in excess of the minimum specified as to permit great variation in braking effect. The logic of the situation would seem to require, either that the present specification be raised, or that a maximum coefficient as well as a minimum be specified.

4. That it would be well to equip the Association's testing machine for determining the wearing qualities as well as the frictional qualities of brake shoes, and to this end we would recommend that the question of proceeding with the construction of such equipment be referred to the executive committee.

Air-Brake Hose Specifications.

Committee—Le Grand Parish, chairman; J. Millikin, T. S. Lloyd, R. L. Ettinger.

In submitting the air-brake hose report from the engineering laboratory of Purdue University, your committee arrived at the following conclusions:

1. It thinks in time that a chemical standard should be set for the rubber in the tubes and friction. It is believed at the present time that the physical tests which are now the standard of the Association are not conclusive, and from information which has been brought to the attention of the committee during the past year, your committee believes that the government chemists and superintendents of tests, and the chemists of some of the large corporations, have now arrived at a point in connection with tests of rubber where they are able to determine within a very small per cent. the amount of shoddy or substitute which is being used to adulterate the pure gum.

2. It believes that in time the bursting pressure and chemical analysis of the rubber and grade of duck should make up the specifications. In order to do this your committee would recommend that a committee composed of several of the railroad chemists give the matter of chemical analysis a thorough investigation with a view of making a report to the Association.

3. The life of the air-brake hose depends upon the purity of the rubber. This conclusion is arrived at from a study of the report, which shows plainly the rapid deterioration of the inner and outer tubes.

4. Your committee is satisfied, from a careful study of the stretching test, that a physical test will not give any idea of the life of the hose. This leads to the conclusion that it is possible to develop a system of ageing the hose by some thermal or chemical method, which will give a general idea of what the condition of the rubber would be after various periods of service. This will eliminate a great deal of the uncertainty of determinng the cause of the failure.

Your committee feels that we should call attention to the mechanical conditions which bring about failure in air-brake hose. Observations lead to the belief that very little advance has been made in eliminating the cause of this damage. The committee has had presented to it a report from one of the prominent railroads, which shows conclusively the fact that 85 to 90 per cent. of the failures may be attributed to external or mechanical causes, and cannot be said to be due in any way to the quality of hose.

It is a well-known fact that some roads are now using a cheap hose, and thus getting a low cost per car per year. The committee feels that this is not the only thought to be considered, but that safety of trains, passengers' lives, and the tremendous cost on account of wrecks, must not be lost sight of.

Your committee herewith presents a specification for woven and combination wrapped and woven air-brake hose for the consideration of the Association. In submitting this specification your committee has had in mind the necessity of having it in line with the present wrapped hose specification.

It is believed that the tensile test will be valuable in determining the quality of the rubber.

SPECIFICATIONS FOR WOVEN AND COMBINATION WRAPPED AND WOVEN AIR-BRAKE HOSE.

All air-brake hose under this specification is to consist of not less than three plies of woven, braided or knitted fabric, or of two or more plies of canvas wrapping surrounded by at least one ply of woven, braided or knitted fabric. The hose should be flexible without kinking easily. The rubber, fabric or duck should be the best of its kind made for the purpose, and no rubber substitute or short fibre will be allowed.

The inner tubes should be composed of three calenders of rubber and not less than 3-32 in. thick at any point. Should a machine-made tube be used, it must not be less than ⅛ in. thick at any point. It must be free from holes and imperfections, and in joining it must be so firmly united to the cotton fabric that it cannot be separated without breaking or splitting the tube. Each ply of the hose should be separated by a distinct layer of rubber, and over this is to be a cover 1-16 in. thick and at each end a 1-16-in. cap should be vulcanized on, the cover and the cap to be of the same material as the inner tube.

The hose is to be furnished in 22-in. lengths, and variations exceeding ¼ in. from this length will not be permitted. The rubber caps at each end are not to be less than 1-16 in. nor more than ⅛ in. thick. The inside diameter of the hose must not be less than 1⅜ ins. nor more than 1 7-16 ins., nor must the outside diameter be less than 2 1-32 ins. nor greater than 2 3-32 ins. The hose must be smooth and regular in size throughout its entire length.

Each hose must have vulcanized to it a badge of white or red rubber as shown; on the top of the badge the name of the purchaser, on the bottom the maker's name, on the left-hand end the month and year of manufacture, and on the right-hand end the serial number and the letters "M. C. B. Standard." The letters and figures must be clear and distinct, not less than 3-16 in. in height, and stand in relief not less than 1-32 inch, so they can be removed by cutting without endangering the cover. Each hose must also have vulcanized to it a badge of rubber showing the copyright, as shown.

Each lot of 200 or less must bear the manufacturer's serial number, commencing at "1" on the first of the year and continuing consecutively until the end of the year, and the serial number should not be duplicated, even though the hose bearing the original numbers be rejected. For each lot of 200, one extra hose must be furnished free of cost.

TESTS TO WHICH SAMPLES WILL BE SUBJECTED.

Bursting Test.—All hose selected for test will have a section 5 ins. long cut from one end and the remaining 17 ins. will then be subjected to a hydraulic pressure of 400 lbs. per sq. in. for ten minutes, which it must stand without failure. At a pressure of 100 lbs. per sq. in. it must not expand more than ¼ in. in diameter or change in length more than ¼ in., nor develop any small leaks or defects.

Friction Test.—A section 1 in. long will be taken from the 5-in. piece previously cut off, and the quality determined by suspending a 20-lb. weight to the separated end, the force being applied radially, and the time of unwinding must not exceed 8 ins. in ten minutes.

Stretching Test.—Another section 1 in. long will be cut from the balance of the 5-in. piece, and the inner tube or lining will be separated from the ply and cut at the lap. Marks 2 ins. apart will be placed on this section, and then the section will be quickly stretched until the marks are 8 ins. apart and immediately released. The section will then be re-marked as at first, and stretched to 8 ins., and will remain so stretched ten minutes. It will then be released, and ten minutes later the distance between the marks last applied will be measured. In no case must the test piece break or show a permanent elongation of more than ¼ in. between the marks last applied. One-in. strips will also be taken from the cover and will be subjected to the same test.

Tensile Test.—Another section 1 in. long will be cut from the remainder of the 5-in. piece, and the rubber tube or lining will be separated from the ply and cut at the lap. It will then be reduced in the middle for a distance of 2 ins. by ½ in. wide parallel. The parallel section shall be spread to the full width of 1 in. at the ends by curves of ½-in. radius. This specimen shall be stretched uniformly by gripping the enlarged ends, and in no case should the tensile strength per square inch be less than 400 lbs., nor the elongation at the time of failure less than 8 ins., measured by marks placed originally 2 ins. apart before breaking.

If the test hose fails to meet the required tests the lot from which it was taken may be rejected without further examination and returned to the manufacturer, who shall pay the freight charges in both directions. If the test hose is satisfactory, the entire lot will be examined, and those complying with the specifications will be accepted.

Triple Valve Tests.

Committee—A. J. Cota, chairman; T. W. Demarest, E. W. Pratt, F. H. Scheffer, F. W. Brazier.

During the past year a triple valve containing new features has been placed on the market by the Westinghouse Air Brake Company, and this valve in two sizes was submitted to your committee for test.

This valve, which is designed for freight equipment, contains three principal features not found in valves previously tested for the Master Car Builders' Association. They are as follows:

First, a quick service application.

Second, a retarded release.

Third, a retarded recharge.

Several of the tables accompanying this report show the circumstances and conditions under which these features will obtain.

The two sizes of this valve are designated as K-1 for 8-in. cylinders and K-2 for 10-in. cylinders.

The Westinghouse Air Brake Company has, for some time, furnished a triple valve designated as H-49 for 10-in. brake cylinders. This valve is similar in design to the F-36 valve and only differs from the latter in the capacity of handling larger volumes of air. No previous tests of the H-49 valve have been made by an M. C. B. committee.

Your committee expected that an entirely new type of triple would be submitted for test on the Purdue rack and arrangements

were completed for making these tests. However, at the last moment the manufacturers withdrew from the test, intimating that a test of 50 cars was not satisfactory and stating that if the M. C. B. requirements were changed from 50 to 80, 90 or even 100 cars, they would be glad to turn their valve over to the committee for test. This communication was received too late for your committee to make arrangements for conducting the test on a 100-car rack.

Your committee fully appreciates the fact that a 50-car test as provided for in the M. C. B. code, does not develop the conditions that must be met in handling trains of 80 or more cars.

The Westinghouse Air Brake Company in offering its new type of triple for test, stated that these valves would materially improve the operation of brakes on trains of 50 cars or less and were especially designed to meet the conditions which develop in handling trains of 80 or more cars. This company also stated that there was little to be gained by making a 50-car test and they would prefer making a test of 75 or 100 cars. Your committee advised the Westinghouse Air Brake Company that the testing rack at Purdue could not be used for more than a 50-car test. The Westinghouse Air Brake Company then offered your committee the use of either one or both of its 100-car test racks at Wilmerding. This offer was accepted with the understanding that your committee should have the exclusive use of the rooms, with the privilege of using either rack for testing triple valves manufactured by other companies.

Your committee arranged to make test on April 5, 6 and 7 1906, and invited the Air Brakes Association to appoint a committee to assist in making tests.

It will be noted by the test records, Appendix II, that all application tests were made with an 8-inch piston travel, while the code specifies 4, 6 and 12 in. piston travel. Your committee found that an 8-in. piston travel more nearly approximated actual conditions in road service and, therefore, felt justified in making tests under road conditions.

The G-6 brake valve was used throughout the tests.

Appendix I illustrates and describes the valve; Appendix II gives in detail the results of tests of the valve, made in accordance with the requirements of the M. C. B. code of tests.

Your committee is of the opinion that a new code of tests for trains of 75 or 100 cars should be compiled. It would also recommend that the testing rack at Purdue University be redesigned to allow of testing as many as 100 brakes of either 8-in. or 10-in. equipment.

AUTOMATIC CONNECTORS.

Committee—F. M. Whyte, chairman; C. E. Fuller, F. H. Clark, George W. Smith.

The notice sent out by the secretary to the members of this committee notifying them of the appointment of the committee and the membership of it outlined the duties as follows: "The committee to prepare standard dimensions for automatic couplings for steam heat, air brake and air signal, also to fix the relative locations and dimensions of the different parts, so that as cars are equipped from time to time with such automatic coupling the various makes will be interchangeable, one with another."

It is recommended that these devices be called connectors, instead of couplings; so that in writings and in conversations they may be distinguished the more readily from the drawbar device. This report will refer to them as automatic connectors.

Of the automatic connectors now in use there are two general types, the important difference, and the one which must be reconciled before the instructions to the committee can be carried out, is the line on which two engaging connectors are parted. In the one type the parting is on a line at right angles to the center line of track; these make a butt joint and may be referred to as butting connectors. The other type is parted on a line parallel with the center line of track; this may be referred to as the lapping connector. It would be impossible to couple one type directly to the other.

The lapping type is made by one company, and we have their opinion to the effect that their patents would prevent others from making a connector similarly parted. The butting connector is made by at least four firms, and the interchangeability of the four butting connectors can be readily accomplished. There are some of both types in service.

Your committee thinks that under the circumstances it is not warranted in recommending either type as standard, but because of the patent situation it favors the butting connector. If these views meet with the approval of the Association, it is recommended that the present committee be continued, or a new committee be appointed and requested to follow out, with respect to the butting connector, the instructions quoted in the first paragraph of this report.

The committee recommends further that the railroads discourage the use of automatic connectors until the manufacturers make arrangements by which any company may make a connector which will couple with the connector made by any other company.

SUBJECTS FOR COMMITTEE INVESTIGATION DURING THE YEAR 1906-1907.

Committee—James Macbeth, W. E. Fowler, O. M. Stimson, R. P. C. Sanderson, F. E. Davis.

First.—Up-to-date passenger car cleaning.

Second.—By introduction or use of the solid knuckle, would it not be advisable to increase the limit of variation in height of couplers from 3 to 4 inches, minimum height 31 inches, maximum 35 inches?

Third.—The present brake head should be made so as to allow the brake beam to hang horizontal as near as possible for either inside or outside hung brakes, at the M. C. B. standard heights of 13 inches for inside and 14½ inches for outside, and make a standard distance between the face of the M. C. B. standard brake shoe and the fulcrum hole of the beam for live and dead lever.

Fourth.—Passenger car ventilation.

Fifth.—Wheels for cars of 100,000 pounds capacity and the stresses to which they are subjected.

Sixth.—Best location and use of the conductor's brake valve.

MASTER MECHANICS' ASSOCIATION.

ABSTRACTS OF PAPERS AND REPORTS.

(Continued from page 288.)

WATER SOFTENING, FOR LOCOMOTIVE USE.

Committee—J. A. Carney, chairman; L. H. Turner, R. Quayle, C. E. Fuller, J. F. Dunn, J. G. Neuffer.

While your committee has expressed itself that the purification of water before delivery to the locomotive boiler is desirable, it also realizes that there may be conditions where the cost of erecting a purifying plant might not be advisable, and that some treatment of the water in the boiler is necessary. Whatever the treatment may be, a carefully systematized blowing-off process must be instituted without which no treatment of water in a locomotive boiler can be successful.

The committee gives below a series of reports of the results obtained by treating water, both before feeding it into a locomotive boiler and treating it in the boiler.

NO. 1.—CONTINUOUS PROCESS.

The following is a brief report of the results obtained by a railroad purifying water by means of a continuous process. There are ten plants in operation and the following figures give the cost of treatment, together with the results obtained. In connection with the treatment of water is an elaborate system of blowing off and washing with hot water:

	Total gallons pumped.	Pumping cost per 1,000 gallons; labor, fuel, etc.	Treating cost per 1,000 gallons, labor, chemicals, etc.	Total per 1,000 gallons
A*........	128,900,000	4.00 cents	1.80 cents	5.80 cents
B..........	48,085,000	2.16 "	1.27 "	3.42 "
C..........	38,000,000	2.11 "	1.48 "	3.59 "
D..........	47,360,000	1.3 "	1.18 "	2.48 "
E..........	47,200,000	1.1 "	1.24 "	2.34 "
F..........	200,300,000	0.6 "	1.07 "	1.67 "
G..........	44,690,000	0.7 "	2.03 "	2.73 "
H..........	18,290,000	3.52 "	3.26 "	6.78 "
I..........	28,630,000	2.93 "	2.53 "	5.46 "
K*.........	22,700,000	7.00 "	4.02 "	11.02 "
Total........	624,155,000			

Average cost of pumping, including cost of fuel, labor, etc. (No interest on investment and no allowance for deterioration) per 1,000 gallons..............2.037 cents.
Average cost of treatment, including labor, chemicals, etc. (No interest on investment and no allowance for deterioration) per 1,000 gallons..............1.589 cents.
Total average cost of water per 1,000 gallons pumped, treated and delivered to storage tanks.........3.626 cents.

*Water is purchased at 4 and 7 cents per 1,000 gallons, respectively.

Also please find statement showing the practical result as found from our reports of August, 1902, using untreated water, and November, 1905, when treated water was very generally used, relating to leaking engines and boilers washed.

TRAINS GIVEN UP.
August, 1902 27
November, 1905 .... None.

ENGINES SETTING OFF CARS ACCOUNT OF LEAKING.
August, 1902 13
November, 1905 .... None.

ENGINES CUT OFF THROUGH TRAINS ACCOUNT LEAKING.
August, 1902 45
November, 1905 5

ENGINES HAVING TUBES CAULKED.
August, 1902 803
November, 1905 469

BOILERS WASHED.
August, 1902 466
November, 1905 146

BOILERMAKERS' WAGES.
August, 1902 ....$401.50
November, 1905 .... 210.90

BOILERWASHERS' WAGES.
August, 1902 ....$485.50
November, 1905 .... 399.75

LIFE OF TUBES AUGUST, 1902.
20 by 26 inch cylinder consolidation, 11 to 12 months.
21 by 30 inch cylinder consolidation, 8 to 10 months.

LIFE OF TUBES NOVEMBER, 1905.
20 by 26 inch consolidation...........27¼ months.
21 by 26 inch consolidation...........13½ months.

About 10 per cent. less engines handled in 1905 than in 1902; 20 by 26 inch engines in somewhat lighter service in 1905 than in 1902. Other engine service the same.

The water is treated for carbonate of lime, sulphate of lime and sulphuric acid by the use of lime and soda ash, applied through the continuous system. The treatment of water causes some boil-

ers to foam; this is taken care of by the water-changing devices which enable the complete discharge of the contents of a boiler containing 2,500 gallons and fill it and have the engine ready for service in thirty-two minutes without dumping the fire.

The report of comparative cost of boiler washing with and without treated water, includes the cost of water changing.

We are not able to show to what extent the life of the fire boxes has been increased, but boxes that were scheduled to be renewed one year ago are in service and doing well. The life of the tubes has been materially increased. The greatest benefit derived from water purification is the ability to keep locomotives in more constant service, with a great reduction of engine failures.

NO. II.—INTERMITTENT PROCESS.

The following is a report from a railroad using an intermittent process of water purification:

The water is mixed with chemicals and allowed to flow into a settling tank. After the sediment has settled the water is pumped into service tanks, two or three settling tanks being used at one plant. Through the use of purified water, 35 boilermakers at $10.40 per hour and 42 boilermaker helpers at $7.09 per hour in 1902, have been reduced in 1904 to 23 boilermakers, costing $7.71 per hour, and 35 boilermaker helpers, costing $6.70 per hour. This shows a decrease in the cost of boilermakers of 21.4 per cent. and a decrease in boilermakers' force of 56 per cent. The greater proportion of skilled help used in 1905 than in 1902 accounts for the discrepancy between the saving and cost and reduction of force. The tabulated statement gives the reduction in number of boiler failures through the use of purified water:

	August, 1902, to and including June, 1903.	August, 1903, to and including June, 1904.
Leaky flues	544	99
Leaky fireboxes	33	20
Leaky arch tubes	6	1
Total	583	120

There has been a reduction of 80 per cent. in boiler failures in 1903, over 1902 and the reduced number of failures was made with an increased tonnage. In 1902 there were 2,934,930.377 ton-miles handled with 28.7 pounds coal per 100 ton-miles; in

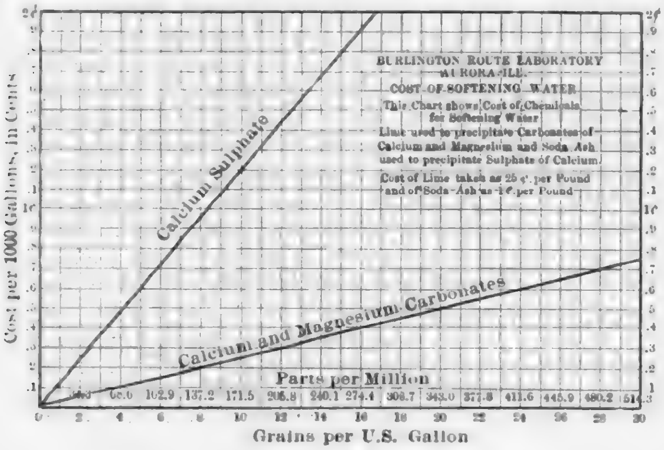


FIG. 1.

1903, 3,154,484,507 ton-miles were handled with 27.5 pounds per 100 ton-miles.

In 1902 159 engines were used and in 1903 154 engines were used with 6.6 per cent. increase in ton-miles, with a saving of 4 per cent. in the number of engines.

The above figures show that the boilermakers' force was reduced 56 per cent., the cost of boilermakers 21.4 per cent., engine failures decreased 80 per cent. and the tonnage increased 6.6 per cent., with a decrease of number of engines used of 4 per cent.

It is difficult to say to what extent the cost of labor and material for maintaining engines had been effected by purified water, but it is safe to say that a material decrease has been effected in this direction. Engines that formerly had their flues reset and heavy repairs to fire boxes, are now taken in for repairs to machinery and resetting a portion of the flues only, and from six to eight months' additional service is obtained.

The benefits to be derived and which can not be computed in dollars and cents, are the short time required for engines on the road, due to tight boilers, the better feeling among the men and longer time at terminals, which not only gives time to keep the engines in better condition, but makes a greater saving in coal due to shorter hours on the road and less overtime paid to engine and train crews.

Engines which ordinarily would be held in for emergency relief calls, are now sent out in regular service, so that a better distribution of power can be made. These items are very difficult to reduce to dollars and cents value, but they mean an immense saving.

NO. III.—MECHANICAL PROCESS.

The following is a report from a railroad using a process for purifying water after it is fed into the boiler:

The device used consists of a system of perforated pipes and blow-off cocks. The water is purified by a special oil introduced into the boiler. The success of this device depends upon absolutely living up to the blowing-out instructions. The results obtained are as follows:

First—Decrease in the times locomotives have their boilers washed which amounts to	83	per cent.
Second—Increase in service of flues between resetting of	24.82	per cent.
Third—Increase in average mileage per engine between engine failures	147	per cent.
Fourth—Increase in mileage of engines between resetting and removing of flues of	7.35	per cent.

The fire boxes are kept comparatively free from scale, which reduces the amount of boiler work necessary and increases the life of fire box. This system of purification shows a decrease in the cost of operation of $1,323.03, or equal to 41.7 per cent. For less number of times boiler washing, has been calculated on $15 per day for engine and for the period of one month will amount to $2,025. The saving in wear and tear to machinery is estimated at $25 per engine per year, and amounts to $400. These figures added to the decrease of operation, $1,323.03, will make the total saving for one month of $3,748.03, or a saving for a period of one year of $44,976.36.

Below is detailed statement of above figures:

	Chemical Treatment.	Mechanical Treatment with Oil.
Number of times boilers washed	1,117	192
Cost of operating chemical plant	$454.29	
Cost of washing boilers	$2,721.51	$490.77
Cost oil used in oil treatment		$1,362.00
	$3,175.80	$1,852.77
Decrease in cost		1,323.03
Per cent. in decrease in cost		41.7%

In addition to the above, the following estimated saving is effected:

Saving in time due to washing 925 additional times at 3 hours and 30 minutes each, equals 130 days at $15 per day for engine hire	$2,025.00
Saving to wear on machinery per month on the basis of $25 per engine per year, cylinder and valve work only	400.00
Total saving	$3,748.03
Percentage of saving	118 per cent.

Engines equipped with mechanical device, washed once a month.

Engines when using chemically treated, washed on an average of every five days.

NOTE.—As shown, the above performance is based on washing engine once a month, and while this can be done, conditions must be favorable. There are, however, times when conditions are such that require washing of engine twice monthly and in these cases we would arrive at the following figures:

	Chemical Treatment.	Mechanical Treatment
Cost of operating chemical plant	$454.29	
Cost of washing boilers	2,721.51	$981.54
Cost of oil used in oil treatment		1,362.90
	$3,175.80	$2,344.44
Decrease in cost		831.36
Per cent. saving		26%

NO. IV.—CONTINUOUS AND INTERMITTENT PROCESS.

This railroad is using a number of different devices for water purification. The continuous process and the intermittent process of treatment before the water is fed to the boiler and also treatment in the boiler.

On 206 miles of main line there are five water stations furnishing purified water, four of them being continuous process and one intermittent.

The flue failures causing a delay of more than five minutes on the divisions using this water have decreased as per following table, which includes freight and passenger:

Year.	No. Failures.
1901	805
1902	395
1903	332
1904	169
1905	135

NOTE.—No purified water in 1901, part purified in 1902-1903, and all water supply purified in 1904-1905.

During 1904, 1905, and for the four months in 1906, there have been no delays to passenger trains on the 206 miles using purified water, on account of leaky flues.

One division has been equipped for feeding from two to five grains per gallon to the suction pipe of the pump delivering the water to the supply tubes. The record of flue failures for thirteen months is as follows:

Year	1905	1905	1905	1905	1905	1905
Month	Jan.	Feb.	Mar.	April	May	June
Failures	11	18	1	1	1	3

Year	1905	1905	1905	1905	1905	1905	1906
Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
Failures	4	1	1	1	0	0	0

Engines using this treated water are equipped with a single perforated blow-off pipe in the back water leg of the fire box. It has been found that the mud works toward the back water leg and frequent systematic blowing off will keep the mud down to a minimum.

The following statement shows the saving made, due to treatment as above outlined:

FAILURES DUE TO LEAKY FLUES.

	No. Failures.	Total Mileage.	Miles per Failure.
Nov. and Dec., 1904, and Jan., 1905...	27	567,115	21,004
Nov. and Dec., 1905, and Jan., 1906...	1	605,196	605,196

	Staybolts replaced.	No. Men in Roundhouse.
Nov. and Dec., 1904, and Jan., 1905...	498	5 boilermkrs. 2 helpers
Nov. and Dec., 1905, and Jan., 1906...	103	2 boilermkrs. 2 helpers

	Boilers Washed. No. Times Washed.	Miles per Washing.
Nov. and Dec., 1904, and Jan., 1905...	389	1,432
Nov. and Dec., 1905, and Jan., 1906...	325	1,862
January, 1905.........................	107	1,620
January, 1906.........................	63	3,175

Engine 1718 ran from January 1, 1906, to February 8, 1906, as an experiment, and made 5,100 miles, and when opened up for washing, no more mud was found on the ring than in an engine which had made considerably less mileage.

Switch engine 1426, built new December 27, 1902, in constant service twenty-four hours per day, commenced to use the water treated by intermittent system in April, 1904; engine was given a general overhauling April 17, 1905, and no flues removed. It came into shop for a second overhauling February 10, 1906; flues were removed for inspection and it was found that they were barely coated with a fine powder which could be brushed off the iron. The switch engine was washed out every thirty days.

Consolidation engine No. 3164, in pusher service twenty-four hours per day, had flues reset September, 1904; the engine came in for general overhauling November, 1905, and the flues were removed. It was found there was practically no scale on any of the flues or accumulation of mud or scale in any part of the boiler. This engine had been using purified water exclusively and the flues were removed for inspection. Both this engine and the switch engine mentioned above were blown out twice a day.

The cost of treatment for chemicals is shown in diagram No. 1. Lime quoted at ¼ cent per pound, and soda ash at 1 cent per pound.

It is difficult to determine how much scale-forming matter should be contained in a water before purification is necessary. The most approved method of water treatment does not remove all of the scale-forming material and it would be useless to treat waters so low in incrustating solids that they approached the quantity which the purifying process failed to remove.

Waters containing over three grains of calcium sulphate or magnesium carbonate, whether there is other scale-forming material or not should be treated. The treatment will not remove all of the scale-forming matter, but will convert the sulphate into carbonate, which produces scale to a much less degree than does calcium sulphate. Water containing over six grains of total incrustating solids, a part of which is sulphate, should be treated.

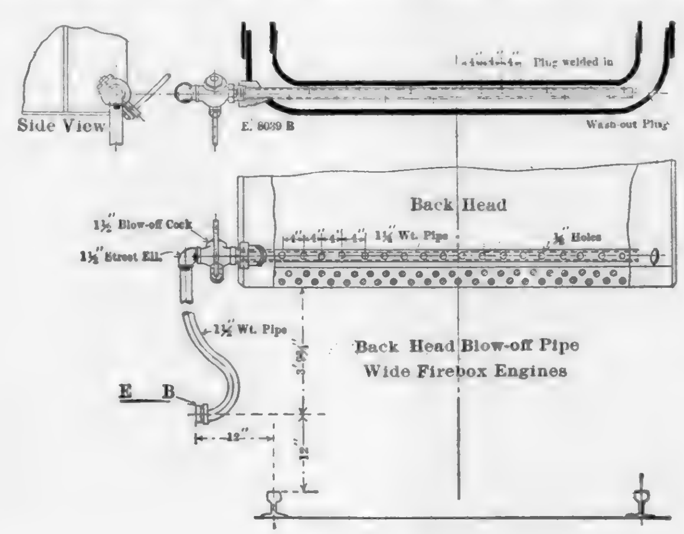


FIG. 2.

Water containing eight grains of incrustating solids, all of which are carbonate, should be treated. Any trace of free acid should be neutralized before the water is fed into the boiler.

There is no known method of treatment for alkali, and the only way to overcome its bad effects is to blow out the boiler systematically and thereby prevent the concentration of alkali, which will produce foaming. Systematic blowing off is necessary in any method of treatment and will do great good, even if no purifier is used.

An arrangement of perforated blow-off pipe placed at the bottom of the back water leg of a fire box is shown on diagram No. 2. This arrangement has been used on the C. B. & Q. R. R. for some time and has given most excellent results, keeping the boiler as free from mud as a much more complicated system of blow-off cocks would accomplish. A floating outlet pipe in the supply tank will be found of great benefit with muddy water, whether purified or not.

Your committee is indebted to Mr. C. M. Davidson, Chemist and Engineer of Tests of C. & N. W. Ry., and Mr. M. H. Wickhorst, Engineer of Tests, C. B. & Q. R. R., for information, method of treatment and results.

SPECIFICATIONS FOR CAST-IRON TO BE USED IN CYLINDERS, CYLINDER BUSHINGS, CYLINDER HEADS, STEAM CHESTS, VALVE BUSHINGS AND PACKING RINGS.

Committee—G. R. Henderson, chairman; E. D. Nelson, Max H. Wickhorst.

It is recommended that all purchases of pig iron be made by analysis. This necessarily implies penalties for non-conformity with specifications, and the amount of silicon is considered to be of prime importance as indicating the grade. High silicon irons —that is, low foundry numbers—are generally dearer than low silicon (high numbered) irons, and if the shipment does not contain the desired percentage of silicon, payment is made accordingly. Sulphur is the element to be most carefully kept down to the limit, and an excess of this substance will generally entail rejection under any grade.

When purchasing cylinders, valves, etc., analyses and test bars should be insisted upon, to demonstrate that the metal is in accordance with the desired specifications.

A locomotive cylinder should combine strength and hardness —the former to prevent breakage, the latter to retard wear; however, it must not be brittle and must admit of machining. A cylinder may be made of tough iron and a hard bushing inserted to give the wearing qualities. In fact we know of recent cases in which the cylinder shell has been a steel casting, with cast iron bushings inserted in the piston and valve chambers. Shrinkage must also be considered, as when excessive there are apt to be cooling cracks present in the casting.

When the silicon is above 1.80 per cent., excessive wear may be expected, but when below 1.00 per cent. there is liability to crack in cooling or in service.

Your committee recommends the following specifications for metal in locomotive cylinders:

Silicon	1.25-1.50 per cent.
Phosphorus	.50- .80 per cent.
Sulphur	.06- .10 per cent.
Manganese	.30- .60 per cent.
Combined Carbon	.50- .70 per cent.
Graphite Carbon	2.75-3.25 per cent.

Tensile strength, 25,000 lbs. per sq. inch min.

Transverse strength 3,000 lbs. minimum on 1¼-inch round bar, 12 inches between supports.

Deflection, .10 inch minimum on transverse test.

Shrinkage, ⅛ inch in 1 foot as a maximum.

TESTING.

The American Society for Testing Materials gives the following details for testing such castings, and your committee recommends them to the Association:

"The quality of the iron going into castings under specification shall be determined by means of the 'arbitration bar.' This is a bar 1¼ inches in diameter and 15 inches long. It shall be prepared as stated further on and tested transversely. The tensile test is not recommended, but in case it is called for it may be made from any of the broken pieces of the transverse test. The expense of the tensile test shall fall on the purchaser.

"(The tensile test piece should be prepared with threaded ends, 1¼ inches in diameter, and with a central neck 0.8 inch diameter, 1 inch between shoulders, with a 7-32 inch radius at the shoulders, the shoulders being 1 inch in diameter and ¼ inch in length to the thread, the total length of piece being about 3½ inches.)

"Two sets of two bars shall be cast from each heat, one set from the first and the other set from the last iron going into the castings. Where the heat exceeds twenty tons an additional set of two bars shall be cast for each twenty tons or fraction thereof above this amount. In case of a change of mixture during the heat one set of two bars shall also be cast for every mixture other than the regular one. Each set of bars is to go in a single mold. The bars shall not be rumbled or otherwise treated, being simply brushed off before testing.

"The transverse test shall be made on all the bars cast with supports 12 inches apart,, load applied at the middle, and deflection at rupture noted. One bar of every two of each set must fulfil the requirements to permit acceptance of the castings represented.

"The bars shall be molded two in a flask and cast on end; the bottom of the bar being 1-16 inch smaller in diameter than the top to allow for draft. Pattern shall not be rapped before withdrawing. The flask is to be rammed up with green molding sand, a little damper than usual, well mixed and put through a No. 8 sieve with a mixture of 1 to 12 bituminous facing. The mold shall be rammed evenly and fairly hard, thoroughly dried and not cast until it is cold. The test bar shall not be removed from the mold until cold enough to be handled.

"The rate of application of the load shall be from 20 to 40 seconds for a deflection of 0.10 inch.

"Borings from the broken pieces of the arbitration bar shall be used for the chemical determinations. One determination for each mold made shall be required."

While the metal advocated is perfectly suitable for cylinder bushings, as well as cylinders (and we also think for valve bushings), a softer grade of iron is generally used for cylinder heads, steam chests, valve bushings and packing rings. This iron has a silicon content of from 1.60 to 1.80 per cent.; the other

elements remaining about the same. As shown on page 215, Vol. 39 of the Proceedings of this Association, the greatest strength was obtained with silicon at 1.60 per cent., and for cylinder heads and steam chests strength is most important. In packing rings a softer iron is desired to save the cylinder bore, and the strength is also a very important factor to prevent breakage when springing over pistons or from water accumulating in the cylinder.

Flexible Stay Bolts.

Committee.—R. N. Durborow, chairman; F. M. Whyte, C. E. Fuller, O. H. Reynolds.

The original flexible stay bolt, as far as can be determined from research by your committee, appeared about 1878, and was the invention of Herr Wehrenfennig, then Chief Engineer of Material and Traction of the North Eastern Railway of Austria, who also, it is claimed, was the first to draw attention to the need of a flexible connection between the two sheets of the boiler. This bolt in general design is similar to practically all that have followed, having a bolt proper with an enlarged head for applying and provided with a seat bearing against another seat provided for in a sleeve screwing into the outer sheet. The firebox end was either fastened by riveting over or by screwing into a cap, but the main difference between this design and later ones is in the form of the seat which, in the Wehrenfennig, was flat, while all others have employed the ball and socket form.

No record of the service given by these bolts can be found, but about four years later an improved form of this bolt was devised and put in service by Mr. W. Leech, Foreman Boiler Maker of the Rajputana-Malwa Railway of India, who, in describing his bolt, stated that a large number were put in service in engines running in bad water districts, and that the bolts gave unqualified success, lessening stay-bolt renewals and prolonging the life of the boiler sheets.

Both the Wehrenfennig and Leech bolts were applied by first tapping the inner and outer sheets so that both holes were in alignment, next applying the sleeves and lastly the bolt itself by means of the square head extending from the head of the bolt, against which a sledge or "dolly" was held while the fire-box end of the bolt was being riveted over, the head remaining as an integral part of the bolt in the Wehrenfennig design, but is removed from the other form after it has served its usefulness in applying the bolt.

Your committee has no data as to how great an extent these early forms of flexible stay bolts were used but it is known that Leech never profited by his invention, from which it would appear that this was one of the useful inventions whose merit was not fully recognized during the life of the patent. This brings the subject to practically the present day, and to determine the experience of members of the Association with bolts of this general form, your committee issued a letter of inquiry to which fifty-eight replies were received. This may be considered as a satisfactory result, even though this does not represent a large percentage of the members of the Association as being interested in the subject. Thirty-two of the fifty-eight replies received were from roads not using flexible stay bolts, but in the twenty-six answers from roads using them, a number of the most prominent roads were included.

Five hundred and twenty-one thousand, four hundred and thirty-five (521,435) flexible stay bolts, of seven different varieties, distributed in 3,012 boilers, have been put in service among the twenty-six roads using such bolts. Of these seven forms, those shown in Figs. 4 and 5 have been the most largely used. The design shown by Fig. 4, which is the earlier one, developed several serious defects traceable to the screw slot by which the bolts are screwed into the sheet. These failures were usually from the bottom of the screw slot through or into the neck, and in some cases in the neck itself. In the former, the head doubled on itself, closing the screw slot, giving very insufficient bearing on the spherical surface. Stopping the slot short of the edge to prevent this buckling did not prove to be a satisfactory solution; hence this form, shown in Fig. 4, has been largely superseded by that shown in Fig. 5, though the service with it cannot be said to have extended over a sufficient period to justify a decision as to its merits. The bolt employs the ball and socket head, but does not use the conical walls for the sleeve for breaking up scale deposited, and aside from the fault indicated previously, Fig. 4, has given satisfactory service, some roads replying that they have experienced no failures, but all roads that have adopted it as standard report otherwise, showing the advantage of wide experience.

In point of favor, indicated by the number in use, Fig 6, (not reproduced) follows the preceding forms, and, regarding the design, appears to be the most satisfactory, as only one road reports a failure, this failure being caused by faulty manufacture in punching the hole for the wrench too deeply. The ordinary ball and socket joint, having a bearing between the bolt and the sleeve, is used, the walls of the bore of the sleeve being conical and very short, and your committee believes that this latter feature is an improvement on the designs shown by Figs. 4 and 5, inasmuch as the space for the lodgment of scale is lessened.

Fig. 7 shows the latest design, and though of comparatively recent date has been received with great favor, indicating the rapidity with which a new bolt of promising design is given a practical trial in the effort to cure the stay bolt trouble. Its actual service, however, has been of such short duration that nothing can be said in its favor or otherwise. The principles of this design were used in an older form and include the spherical headed bolt and recess with conical walls in the sleeve, but better designed for manufacture and for application.

It has been demonstrated that in certain locations the rigid stay bolt will not give reliable service in the large boilers carrying heavy steam pressure, and though very frequent examination will detect such failures before they become too numerous, nevertheless there is every indication that at certain locations some form of bolt that will allow of distortion without rupture is a necessity.

For solid bolts, some advocate a special grade of material, this being either a higher grade iron made up in the usual way, or iron made up in some special way. Your committee believes that, while good material is by all means desirable, it is firmly convinced that this alone will not overcome the troubles that have been experienced.

Besides changing the material, various modifications in the form have been tried and adopted, the general idea being to so

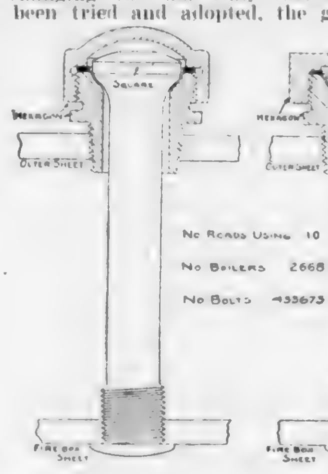


FIG. 5.

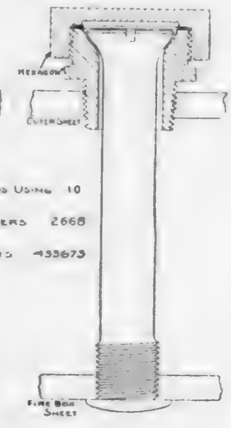


FIG. 4.

shape the bolt that the vibration strains will not all locate themselves at one point, namely, the inside of the outer sheet. One of these special forms employs a bolt which is materially enlarged at the outer sheet, diminishing in diameter until the fire sheet is reached, the governing idea being that, by so shaping the bolt, the deflection will be distributed over its entire length. Experience shows that this result largely follows and that final fracture, when it occurs, may be at some distance from the sheet, but the disadvantage of tapping holes of different sizes in the two sheets, to say nothing of the greater expense of forming such bolt, renders its adoption very doubtful. The custom of reducing the diameter of the bolt between the two sheets, your committee believes to be a good one, provided the reduction is not made by an abrupt shoulder. Vibrating tests on the testing machine indicate that this reduction very greatly increases the capacity of the bolt to resist distortion, but it is the opinion of your committee that the reduction should not be carried too far, as it has been found in practice that with the size of bolts customarily used, a body 3-16 inch less in diameter than that of the ends will give better results than a greater or lesser amount of reduction. Other forms of solid bolts have been used in fittings designed to practically increase the length of the bolt. Various modifications have also been made with the idea of giving the rigid bolt greater flexibility. One of these is a bolt which is flattened locally in planes at right angles to one another, but the results obtained were not satisfactory.

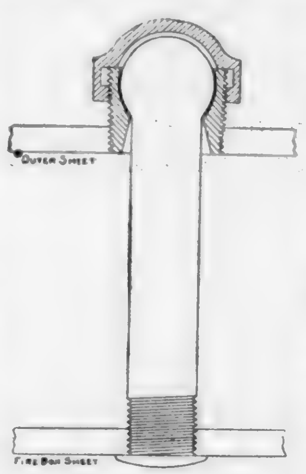


FIG. 7.

Other modifications, such as the milling of longitudinal saw-cuts in the body of the bolt, and of manufacturing the bolts in hollow form, have also been tried; the latter claiming to possess the additional advantage of better combustion and absolute indication of failure. Your committee is not prepared to admit that either of these claims have been proven.

All of these schemes have given more or less satisfaction, but none have fulfilled requirements to an extent that would warrant universal use.

Regarding the opinions of the users of flexible bolts as to the value resulting from a change from the rigid to the flexible form, the verdict is greatly in favor of the change, fifty per cent. of the replies received being in the affirmative and including the largest users; the remainder, excepting one, answering in a manner that could not be interpreted as either for or against their value.

Concerning the location of flexible bolts there appear to be four places applicable to all boilers that have proved to be a source of trouble to rigid bolts, and where the application of flexible bolts has stopped entirely, or to a great extent, the failures of the older form, these places being the two upper corners of the throat and side sheets. Beyond this the application is increased as the individual judgment indicates.

Naturally the results obtained from flexible bolts vary to an extent, depending upon the conditions, these conditions including such items as design of the bolt, application of the bolt, design of the boiler, and incrustation, these four factors being the most important affecting its life. In the bolt itself it is admitted that,

strictly speaking, it is not a flexible bolt, for though it is made in two parts it still has to withstand bending strains, due to the manner of expansion in the sheets, the bending taking place at one point near the inner sheet. This action be overcome by employing a flat bearing surface at right angles to the head of the bolt instead of the ball and socket joint as commonly used. As better contact is maintained between the head and sleeve in actual service with the ordinary form, and further, as trouble has seldom been known to result from the bending strains due to the expansion of the sheets, which would be indicated by bolts breaking at some point near the inner sheet, or by leaking at the firebox end (a trouble that is seldom, if ever, encountered), it is evident that this is a trifling fault, but one that should be borne in mind while considering the designing of new bolts. The finding of the point of failure of stay bolts at the outer sheet, and that the failure seldom, if ever, takes place at the inner sheet, is possibly due to the high temperature of the fire box making the inner sheets more elastic. This allows them to bend to an extent, relieving the stay bolt to some degree of the strains imposed upon it at this point. It should also be remembered that in most designs the outer sheet is materially thicker than the inner or firebox sheet.

A simple means of positively detecting cracked and broken bolts is an improvement needed by all flexible bolts that are in service at the present time. The removal of the cap, which will allow a proper examination of the bolt, is the only absolute means possible with flexible bolts of present design. On account of corrosion, it is not an easy method and often results in destruction of the cap. The inspection of flexible bolts located in side sheets and back head can only be made by the removal of lagging. The designing of the flexible bolt, so that the telltale hole may be employed, by filling the space between the head of the bolt and the cap with a packing material, may or may not be a good feature for determining cracked and broken bolts. As the use of the telltale hole is a disputed practice, its action not being accepted as positive, and as it adds to the expense of application and maintenance, it is not to be recommended for this purpose.

The first consideration in the application of bolts should be the securing of proper alignment of the holes in the inner and outer sheets, in order that the clearance between the bolt shank and the sleeve may not be decreased, leaving a larger amount on one side than on the other, and so reducing its value as a flexible bolt when expansion of the sheets takes place, as this will give the possibility of an added strain upon the bolt due to the bolt shank acting as a lever arm with the sleeve as a fulcrum. Also if the bolt and sleeve do not contain the same perpendicular for a center line an indirect strain comes upon both members. These two conditions, which may occur in conjunction, giving complex strains to the bolt and sleeve, will undoubtedly affect the life of the bolt to some extent; but even if each occurs separately, the already severe service of this member of the boiler is unnecessarily added to, reducing its life to an extent commensurable with the increased demands. The cure for these faults is simple, only needing care in the final reaming and tapping of each pair of holes. Unfortunately, however, none of the methods employed in the application of flexible stay bolts were described by the members in their reply to the circular.

There also exists the possibility that in applying the bolts, different ones may be given varying initial strains, those receiving the greatest naturally suffering the hardest service, and it is easily seen that with a great enough difference in initial strain between one bolt and those surrounding it, rupture may be an easy matter.

The effect of the design of the boiler upon the life of the bolt can be seen from the accompanying diagrams, Figs. 29 to 45 (not reproduced) inclusive, which give the records of broken stay bolts. These figures show the failure of both flexible and rigid bolts, and the tabulations on these sheets show the method of indicating such failure and, also, give other information from which it can be said that each class of boiler has its own local weakness at which failure occurs most frequently; but in general it may be said that the point at which there is a bend in the sheet is one where failure may be expeected. In some of the later designs, particularly those of wide fire boxes, the greatest number of failures occur at the first few rows above the mud ring.

Incrustation has been the principal difficulty that flexible bolts have had to contend with and this trouble has been the cause assigned for most failures, there being but little doubt that this is true, for the deposit of solid matter around the bolt and its parts will defeat the purpose of the flexible bolt, making it of little more value than the rigid; and, though the fault may be a local one, affecting only such engines as run in districts supplied with scale-forming water, any design of flexible bolt which will admit of this taking place is in general a weak design.

It may be said that all bolts of to-day possess this fault, though some, in a manner, have obviated the difficulty. A fault common to all lies in the sleeve, which should not be made too large on account of weakening the outer sheet, nor should the bolt be decreased for reasons of strength, the result of either being an increase of clearance around the bolt. The proper procedure is the omission of that portion of the sleeve below the seat of the bolt, thus preventing the possibility of the scale being deposited between the bolt and sleeve, preventing free movement of the bolt with the movement of the sheets. Some designs have made use of a conical wall in the sleeve to aid in keeping the scale from collecting, but it has been found from experience that this feature, aided by the movement of the sheets and continual jarring of the engine, does not serve its purpose under all conditions. Such scale that is deposited is formed grain by grain, and may result in a hard, homogeneous mass which will take a heavy blow to break up, yet the only action that takes place between the bolt and sleeve is of a grinding nature, which at the most will keep but a small space around the bolt clear, and any movement beyond the average demanded of the bolt will not be met.

In such varieties of bolts that use the flat head, incrustation will surely produce a solid bolt if conditions are favorable, the time depending on the amount of clearance between the bolt head and cap, for water and steam get past the seat of the bolt and sleeve, depositing such salts as may be contained. With the spherical headed bolts this cause of rigidity may be overcome or lessened, for, theoretically, all the clearance required by this form is anything less than actual contract and, practically, enough to provide for irregularities due to manufacture. It is safe to assume that this amount of clearance will always be present, due to vibration and movement of the bolts.

There has been a small amount of trouble that neither of the above forms provide for, namely, if scale is deposited above the head of the bolt, no provision is made for taking care of expansion of the bolt and approaching of the sheets, which has been known to result, with sleeves using brass caps, in the forcing out of the center of the cap. It is evident that the amount of trouble resulting from incrustation depends entirely upon the amount of solid matter contained in the water and whether it deposits as a hard or soft scale.

The fact that there is a movement of the firebox and outer sheets has always been recognized, but what this movement amounts to and the direction it takes appears to have been known only in a vague and indefinite way, an investigation of a thorough character having apparently, from a careful research by your committee, never been conducted. Considering the different sheets that form the firebox of the boiler as plane surfaces, expansion of these sheets takes place in two different planes, one in a plane containing the sheets that may be under consideration, and the second is a plane perpendicular to these sheets, it being a separation or approaching of the inner and outer sheets of the boiler. In an investigation the individual expansion of each sheet is of no definite value, for if both the inner and outer sheets move the same amount in the same direction, no change of position of the stay bolt would take place, but if the expansion of each sheet occurred in opposite directions the movement of the bolt would be greatest. From this it is seen that all that concerns the bolt is the relative movement of the inner sheet with respect to the outer.

The expansion of the two sheets in their own plane, which, for convenience, may be called horizontal, is due to the changes of temperature, but the expansion in the other direction, which may be called the vertical expansion, is due to a combination of forces, among which are the expansion of the stay bolts, the buckling tendency due to the expansion of the sheets in a horizontal plane being confined to a certain extent by the stay bolts and other fastenings, and the separating force exerted by the steam pressure.

In order to obtain definite information that would give the amount and direction of these movements, your committee conducted such experiments that would give this information, and though all data desired were not obtained, yet definite results were accomplished. Starting with the idea of determining only the relative movement of the two sheets, an apparatus was devised, consisting of a casing, containing parts making steam tight joints, screwed in the outer sheet and a plug screwed in the inner sheet. Driven on this plug was a length of seamless steel tubing at the free end of which was attached a brass cap, the brass cap being free to slide against a half-round ring, provided to guard against the non-alignment of holes in inner or outer sheets, and so as either sheet moved in the horizontal plane a steam joint was always kept. Resting on the half-round ring and kept in contact with it by means of a spring under proper compression, was a ground piston capable of being moved up or down, obtaining by this means a steam joint if any movement in this direction took place. These three joints thus provided for any movement whatever that might take place. To provide for the relative movement of the sheets, the table for holding the papers on which the records were made was attached to the casing held by the outer sheet, and the recording levers were connected to the plug fastened in the inner sheet by means of a rod entirely free of all restraining pressures. For the movement of the sheets in a horizontal plane, a pantagraph of usual construction with a ratio at the pencil of approximately eight times the movement at the moving point, and for the vertical movement a simple lever also with a ratio of approximately eight to one, were used.

In addition to the information given by this apparatus the temperatures of the firebox and the outer sheet should be known and an attempt was made to obtain this data, but, due to the difficulties encountered, the attempt resulted in failure.

In conducting the trials two passenger engines, one of the Belpaire and the other of radial stay construction of modern type, which had just passed through the shops for repairs, were selected, and the points of greatest stay bolt failures obtained from the record sheets of these types of engines. Three or four points depending upon the construction of the boiler were selected from each of the four sets of sheets comprising the firebox. After the necessary work had been done on each boiler—which included one injector in proper working order, the throttle valve in good condition, the valves, piston and cylinder heads removed to allow free passage of steam when the throttle was opened, and a measuring device placed in each hole of one of the four sets of sheets—the preliminary data were observed and the fire started in the boiler, steam being raised as quickly as conditions would allow. The method of urging the fire was that found in ordinary engine-house practice and consisted of a steam blower supplied from the engine-house piping, which was used until the boiler pressure was high enough to supply steam for the blower.

Readings were taken at frequent intervals until a steam pressure of 25 pounds per square inch was reached, after which they were taken at intervals of 30 pounds until the normal pressure was obtained, at which point the pressure was allowed to remain stationary for ten minutes, so that the different parts of the fire box might obtain the proper temperature and thus be in a state of rest. At the end of this period the throttle was opened

for ten or twenty minutes, blowing off approximately two gauges of water, keeping steam as near the working pressure as possible. This does not give the intermittent action of using steam in actual practice which may affect stay bolts to some extent, but represents, as near as could be obtained, service conditions. After readings had been indicated on the records, the injector was applied to restore the water used while the throttle was open, not attempting to keep the steam pressure up, as in this way the greatest reduction in temperature of the sheets could be obtained. When the usual readings had been recorded, and steam pressure had been restored, the firedoor was opened for five minutes to obtain a maximum condition to represent the opening and closing of the door while on the road, and which would show distinctly on the record sheet any movement due to this cause. After this period the fire was withdrawn from the firebox and the throttle opened, allowing about fifteen minutes for reducing the pressure to zero, and at this point the blow-off cock was opened, the water allowed to drain, and the boiler, with all devices in place with fresh record cards, left to cool, thus obtaining the action taking place during cooling as well as heating.

[Drawings of the apparatus used and tables showing the results of the tests were included in the report.]

The greatest movement, as might be expected, occurred at the crown sheet and upper corners of the side sheet, but very little took place at the top of the back head where some amount might be looked for, even though this is the firebox sheet of lowest temperature. Practically no movement whatever was shown at the lower corner of the side sheets. This may be explained by the lower temperature, the points measured being in the bed of the fire. The restraining effects of the heavy mud ring and its fastenings probably also contributes to this result.

The greatest movement obtained in a horizontal plane was at point "F" (center of front edge), on the radial stay crown sheet, where the difference in movement of the two sheets amounted to .08 inch and .09 inch—about 3-32 inch—with rising and falling temperature respectively, and to .06 inch in the vertical plane at point "B" (near center of back edge), on radial stay crown sheet with falling temperature. From this it appears that the relative movement is very small, and, from a further examination of the table in but few instances did the difference in movement of the two sheets greatly exceed .015 inch (1-64 inch).

There is very little difference in movement between the radial stay and Belpaire types of boilers. Some claim that a movement of the sheets takes place as the steam pressure varies or when the firedoor is opened during the operation of firing, but referring to the cards, no signs of such movement can be detected. This movement was particularly looked for as the tests progressed, but as no indications were observed, and as conditions were aimed to give results much more severe than would be derived in practical work, it must be assumed that any such movement is infinitesimal in amount. In some of the diagrams a reversal of direction is shown to have taken place and this means the bolt has undergone a reversal of strain which, in the horizontal plane, indicates a bending action taking place. However, little of this reversing took place after the boiler was under normal pressure for ten minutes. Nevertheless it is interesting to know that the line of fracture of broken stay bolts closely agrees with the general direction taken by the sheets in expanding as indicated by the diagram, and that failure is probably due to a repetition of small movements over a long period and aided by the tension exerted by the separation of the sheets.

In conclusion, your committee believes that flexible stay bolts are giving very satisfactory service where the design is good and the conditions are favorable. The only unfavorable conditions which seriously affect the service are bad workmanship and water containing hard scale-forming material; the first condition being less serious than the second.

It has been shown that there is a definite movement of the sheets, of small amount, from the cold boiler to the working pressure temperature and that the movement has an effect upon the life of the bolt. Any small changes of temperature, caused by the operation of the injector, reduced steam pressure, or the opening of the fire door, produce a movement of the smallest amount.

Your committee believes that it is wise to substitute flexible bolts at the points where experience shows the greatest breakage of rigid ones, and that no hard and fast rule can be laid down to show where this occurs, as this location is affected by the design of the boiler; that the flexible bolt must be one designed to minimize the difficulty from incrustation; that it must be of proper strength and with sufficient clearance in its fittings; and finally, that the design should, if possible, be one to facilitate examination. With these conditions observed, your committee is convinced that the flexible bolts will give great relief from the present troubles.

Tire Shrinkage and Design of Wheel Centers.

Committee—F. J. Cole, chairman; J. E. Muhlfeld, A. S. Vogt, W. A. Nettleton.

General.—The dimensions, design and weight of wheel centers should, in a general way, be of suitable proportions to the weight and power of the locomotive. These recommendations, therefore, will be found somewhat too heavy for locomotives of moderate weight, and will be understood as applying to large, heavy, modern engines of proportions such as are used at the present time.

SPOKES.

In order to properly support the rim and to resist the tire shrinkage, the spokes should be placed from 12 to 13 inches apart from center to center, measured on the outer circumference of the wheel center. Your committee would recommend the following approximate rule:

Number of spokes to equal the diameter of center divided by 4. If the remainder is one-half or over, use one additional spoke. The exact spacing of the spokes according to this rule would be 3.1416 x 4 = 12.56.

Wheel centers arranged in this manner would have the following number of spokes:

Size of Center.	No. of Spokes.	Size of Center.	No. of Spokes.
38	10	72	18
44	11	74	19
50	13	76	19
56	14	78	19
62	16	80	20
66	17		

Among patternmakers and foundrymen there is an impression

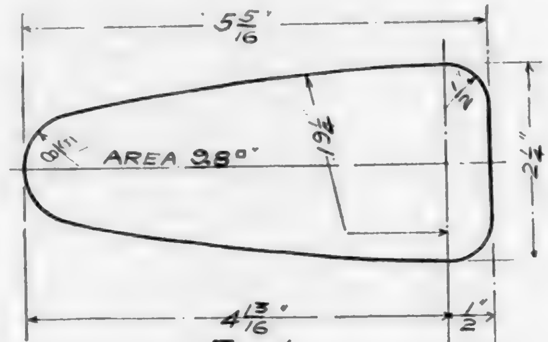


FIG. 1.

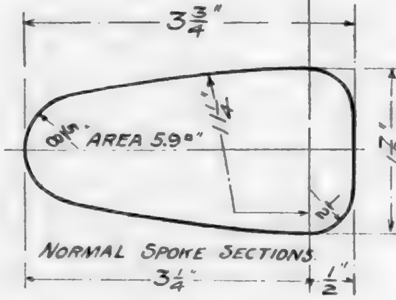


FIG. 2.

that an uneven number of spokes should be used, so as to avoid getting two spokes directly opposite each other in a straight line. The following table has been made up on this basis:

Diam.	Circumference.	Recommended Spokes.	Pitch.
44	138.23	11	12.5
48	150.8	11	13.6
50	157	13	12.6
54	169.65	13	13
56	176	13	13.5
60	188.5	15	12.6
62	194.8	15	13
66	207.3	15	13.8
68	213.6	17	12.5
70	220	17	12.9
72	226.2	17	13.3
74	232.5	17	13.6
76	238.76	19	12.6
78	245	19	12.9

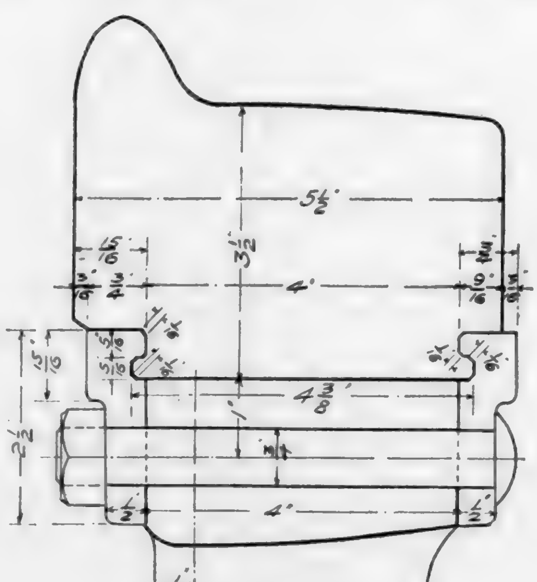


FIG. 5

NYC.&H.R.R.R. RETAINING RINGS.

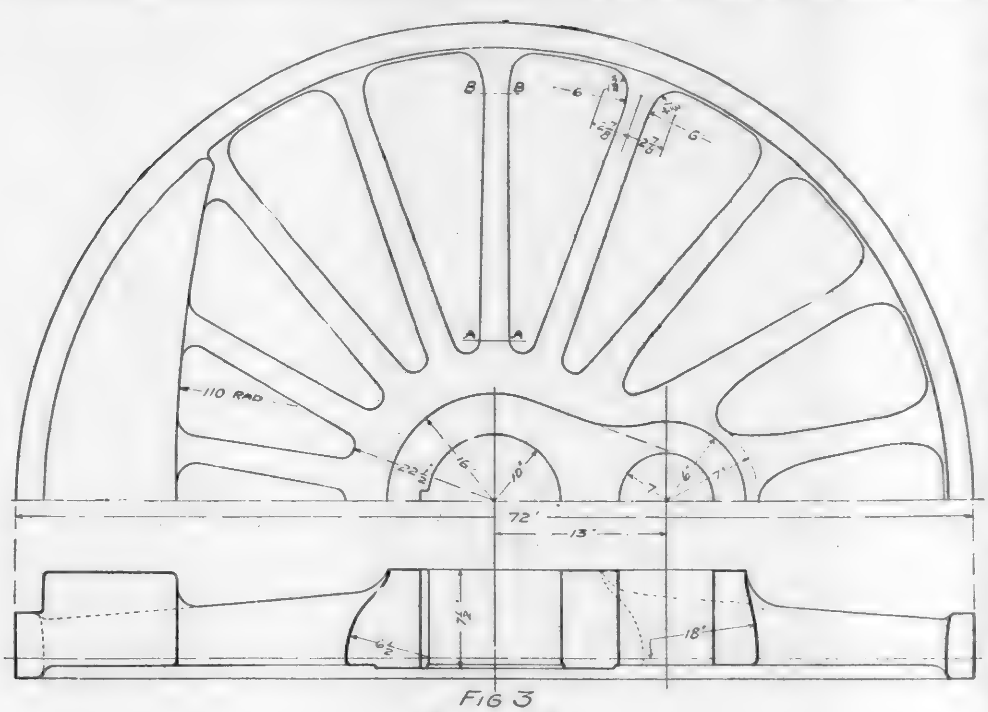


FIG 3
18 SPOKES

In the above table, the pitch of spokes, measured on the outside of rim, is 12.5 to 13.8.

Spokes at crank hub should not be located at center line of wheel, but on either side, so as not to bring a short spoke directly in line with crank pin hub. Sections of spoke to be from 9 to 10 square inches in area, with form as shown in Fig. 1, for the big end. Section at small end to have an area of from 5¾ to 6 sq.-ins., with form as shown in Fig. 2. These sections are taken at the base of the fillets uniting the spoke to the hub and rims, as shown in Fig. 3 at AA and BB. The metal in these sections is distributed so as to give the maximum amount of resistance to the shrinkage of the tires, and with this end in view the section is much heavier directly underneath the part of the tread which bears directly upon the rail head.

RIMS.

Cast-steel driving wheel centers should be preferably cast with the rims uncut and shrinkage slots omitted whenever steel foundries will guarantee satisfactory castings. The P. R. R. Co. have been obtaining wheel centers with uncut rims for the last two years or more. A number of cast steel foundries are now ready to make wheel centers in this manner.

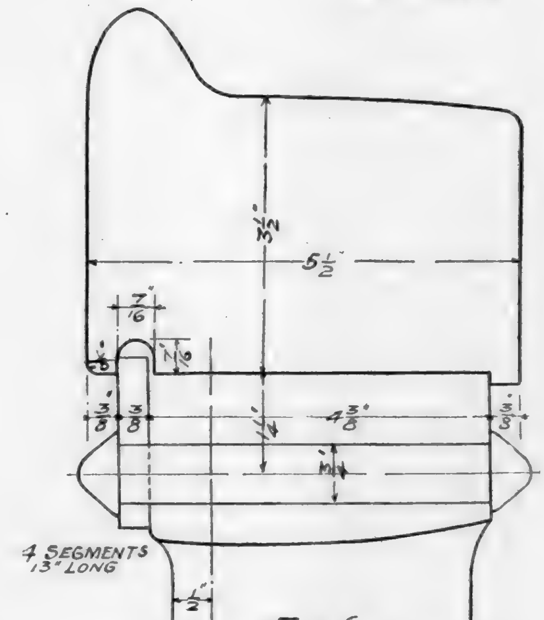


FIG. 6.
P. R. R. RETAINING SEGMENTS.

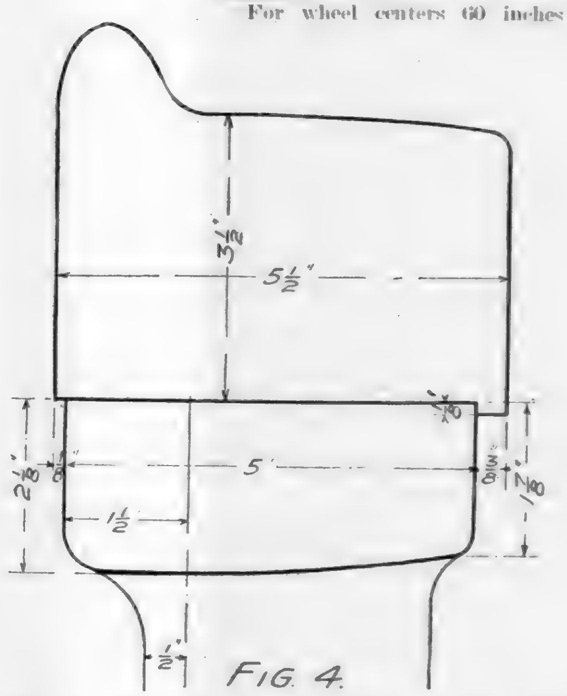


FIG. 4.

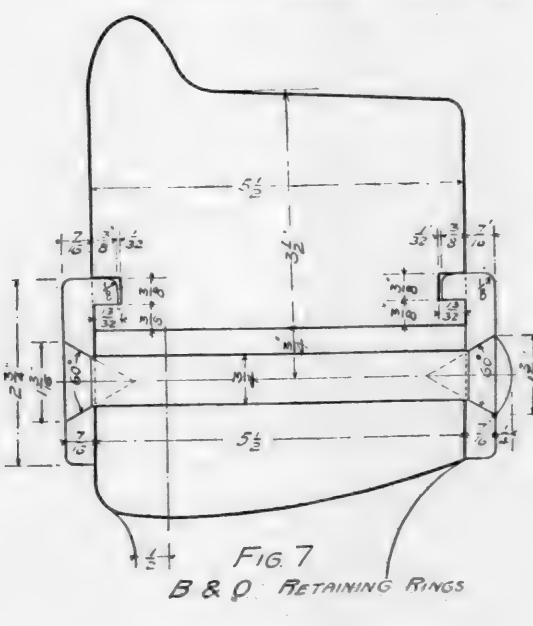


FIG. 7
B & O RETAINING RINGS

For wheel centers 60 inches and over, where the permissible total weight of the engine will permit, the rims should preferably be cast solid without cores, so as to obtain the maximum section and have full bearing of tires. The section in square inches should be approximately .45 of the sectional area of the tires when new; for instance, a 5½ by 3½ inch flanged tire has a sectional area of 20.2 square inches. This would require a rim with 9 square inches of metal. A 3 by 5½ inch flanged tire has a sectional area of 17.5 square inches, requiring a rim of approximately 7.9 square inches. In our opinion, it is not necessary to consider the increased area of flat tires.

It is difficult to get sufficient counterbalance in centers smaller than 60 inches in diameter, so that it will be found very desirable to core out the rims to obtain the maximum lightness on the side next to the crank pin, and in some cases on the counterbalance side, in order to fill in with lead where necessary. Your committee would recommend a rim section as shown in Fig. 4, for wheel centers without retaining rings. The tire is secured from having the center forced through it by a lip on the outside ⅜ inch wide and about ¼ inch high, the tire being left rough at this point. The exact height of the lip therefore depends upon the amount of finish left on the interior of the tire.

RETAINING RINGS.

There is so much diversity of practice in the use of retaining rings that your committee does not feel justified in recommending any particular form.

The standard form used by the New York Central Lines, rim 4 inches wide, is shown in Fig. 5.

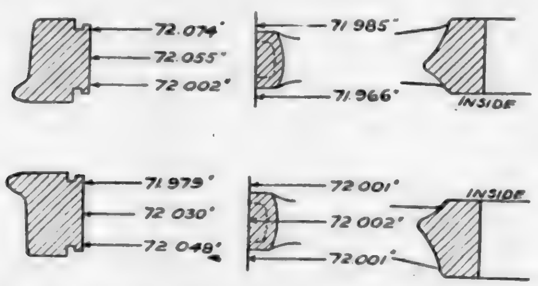
The standard form of Pennsylvania retaining segments is

shown in Fig. 6. The tire is secured by means of retaining segments and a lip on the outside of the tire. The lip is ⅜ inch wide and about ⅛ inch high, and is equal in depth to the amount left by boring out the tires. The four retaining segments are ⅜ inch thick and about 13 inches long, secured by two rivets through each segment, located at junction of spoke to rim.

The standard form of B. & O. Mansell retaining rings is shown in Fig. 7, with a rim 5½ inches wide.

SHRINKAGE SLOTS.

It is becoming more and more the practice of steel foundries



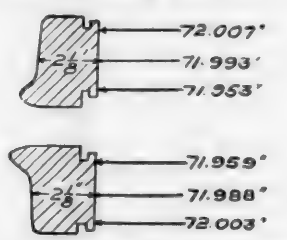
to cast rims without shrinkage slots and several of them are now prepared to guarantee satisfactory results. We would recommend the adoption of this practice whenever foundry methods will permit, as the rim of the wheel is stronger and better adapted to resist the strains to which it is subjected when the rim is left uncut. The extent to which this practice may be used depends entirely upon the attitude of steel manufacturers. It is well known that the shrinkage strains can be taken care of and that cast steel wheel centers of all diameters required for locomotives have been made successfully in this manner for several years.

HUBS.

In order to prevent an excessive dish to the spokes we would recommend that a standard distance of 55 inches between hubs be adopted. This permits the use of a practically straight spoke without dish on the inside.

In boring out the tires and in turning off wheel centers, a wide-nosed tool should be used and care taken that the surface of the finishing cut is not left in ridges. It has been observed that when ridges are left they soon wear flat and decrease the original shrinkage.

Accurate measurements of tires after they have been in service for some time, especially when less than 2½ inches in thick-



STANDARD BORE 71.925".

ness, show that a rolling out or stretching of the tire occurs, and for reasonably heavy centers these figures would account more for loose tires than any permanent set in the driving-wheel center.

In Fig 8 is shown the exact caliper dimensions of the wheel centers and tires which were reported loose on Atlantic engines having about 104,000 pounds weight on drivers. These tires had been previously shimmed, and contained liners between the tire and center .068 inch on the left and .050 inch on the right for the entire circumference.

Fig. 9 shows diameter of tires 2⅛ inches thick, which had been removed from a similar engine. These dimensions appear to confirm the statement that considerable rolling out and stretching occurs when the tire becomes reduced in thickness , and it is especially noticeable that this rolling action of the wheel is most apparent on the outside of the tire where the wear of the rail would be the greatest.

SUBJECTS.

Committee—R. D. Smith, chairman; G. W. Wildin, C. H. Quereau.

COMMITTEE REPORTS, 1907 CONVENTION.

1. The comparative arrangement for coaling stations.
F. F. Hildreth, F. H. Clark, J. B. Barnes.
2. Submit a blank form for use at terminals to give history of the movement of every locomotive from the time it leaves its train until it takes its next train. Object: to secure closer cooperation between the mechanical and operating departments.
G. M. Basford, R. D. Smith, R. P. C. Sanderson.
3. What thickness of tires is the most practical for locomotive driving wheels—3 ins., 3½ ins. or 4 ins. thick? Why?
W. T. Fitzgerald, John Howard, H. F. Bentley.
4. Results of different valve gears on locomotives.
C. A. Seley, A. S. Vogt, G. H. Haselton, Robert Quayle.
5. Proper allowance for fitting axles and crank pins to driving wheel centers and method of registering the pressure.
S. W. Miller, L. R. Pomeroy, S. M. Dolan.
6. Pay for shop and roundhouse labor and comparative merits of day work, piece work, bonus or other systems.
David Van Alstyne, J. F. Deems, W. R. McKeen, Jr.
7.. The proper spacing of flues in high-pressure boilers.
Charles E. Fuller, H. J. Small, F. J. Cole.
8. Supervision in large locomotive repair shops.
G. W. Wildin, H. H. Vaughan, J. B. Kilpatrick.
9. Boiler shop area in square feet, per pit of erecting shop, including cranes, machine and tool equipment.
T. Rumney, A. C. Deverell, A. E. Manchester.

INDIVIDUAL PAPERS, 1907 CONVENTION.

1. Locomotive failures, records and results of keeping them.
Paper by W. E. Dunham.
2. Superheating and compounding from a standpoint of locomotive economy.
Paper by T. A. Foque.
3. Shop cost systems and effect of shop schedule on output and cost of locomotive repairs.
Paper by A. Lovell.
4. Causes for leaky flues.
Paper by M. E. Wells.

MECHANICAL STOKERS.

Committee—W. Garstang, chairman; D. F. Crawford, J. F. Walsh.

Since the last convention there has been little progress made in the development of the automatic stoker for locomotives, as in addition to continued trials of the stoker mentioned in the proceedings of the 1905 convention the committee has advice of trials of but one other stoker. This stoker had in connection with it apparatus for conveying the coal from the tender to the stoker hopper above the fire door. The types of locomotives, nature of service and kinds of coal used by the various railroads, make it very difficult, at the present time, to make any valuable comparisons of the performance of the various types of stokers.

THE MODERN LOCOMOTIVE INJECTOR.
(Individual Paper.)
BY MR. STRICKLAND L. KNEASS.

THE SUPPLY.

The water supply is forced through the narrow entrance to the combining tube of the injector by atmospheric pressure, the available head being the difference between the suction height at the water branch and the vacuum within the combining tube. It is necessary that this entrance area be small, so that the water shall have a high velocity during its time of contact with the steam, but the suction pipe and connections should be of ample size, or the resultant friction will reduce the effective head at the entrance to the combining tube. The pipe diameters recommended for various nominal sizes of injectors are given in the following table:

TABLE I.

Normal Size of Injector.	7	8	9	10	11	12
Iron (Inside)....	1½ ins.	2 ins.	2½ ins.	2½ ins.	3 ins.	3 ins.
Copper (Outside).	1¾ ins.	2¼ ins.	2¾ ins.	2¾ ins.	3¼ ins.	3¼ ins.

(Non-Lifting Injector may use one size smaller.)

The areas of the tank valve and connecting castings should be greater than given in Table I. The perforations of the straining plate should not exceed 3-32 in. diameter, and their total area should be three times that of the suction pipe; the tank should be frequently cleaned and kept free from ashes and coal.

The suction pipe should be short and direct, with easy bends, and preferably of copper. The injector should be placed at or about 6 ins. above the upper level of the water in the tank. The effect of increasing the height of lift is apparent from the following table:

TABLE II.
EFFECT OF HEIGHT OF LIFT.

Height of Lift.	Steam Pressure.	Water Supply.	Capacity in Percentage.
2 feet	200 pounds	75°	100%
6 feet	200 pounds	75°	95%
8 feet	200 pounds	75°	80%

The suction pipe, hose and connections should be absolutely tight under 30 lbs. pressure.

The effect of an increase of temperature of the water supply is to reduce the capacity. Given a normal temperature 65 deg. and height of lift of 2 ft., and the capacity as 100 per cent., increasing the temperature of the water supply to 85 deg. reduces the capacity to 89 per cent., even though the lift is unchanged. The following table shows the effect of temperature of water supply on the capacity at 200 lbs. boiler pressure:

TABLE III.
EFFECT OF TEMPERATURE OF WATER SUPPLY UPON CAPACITY, 200 POUNDS BOILER PRESSURE, 2-FOOT LIFT.

Water Supply	65°	75°	85°	95°	105°	115°	125°	135°
Capacity in Percentage.	100%	96%	89%	80%	72%	68%	67%	66%

The ratio at which the capacity is reduced is not in the same proportion above 105 deg. temperature of water supply as the internal conditions of the jet above that temperature are changed.

The condition of the steam supply is also of great importance; it should be dry and saturated, and conducted through pipe passages large enough to allow full boiler pressure at the steam nozzle of the injector. Wet steam tends to cut the valve seats and nozzles, superheated steam to reduce the mechanical efficiency and the capacity.

INJECTORS.

The action of the injector depends primarily upon the impact of a condensible gas upon its own liquid; the directing and receiving nozzles should be designed and constructed according to the curves that govern the flow under given conditions of velocity and pressure; owing to the high velocities of both the actuating gas and the resultant jet, departure from the correct contour causes rapid and unnecessary wear. The surfaces should be smooth and hard, the metal homogeneous, and without microscopic evidence of porosity, characteristic of all tertiary or quarternary alloys.

The essential characteristic of a boiler-feeding device is certainty of action, because the failure of a locomotive due to a defective injector, although serious enough in its consequences, cannot compare with the injury and loss of life which may result from an exposed crown sheet. Of secondary, but also of great importance from an economical point of view, are the range, efficiency, etc. These desirable points are emphasized under the headings: "Construction," "Performance of an Injector."

CONSTRUCTION.—The design of an injector should be simple and constructed with the fewest parts, as it is easier to understand and cheaper to repair, and the stock of renewal parts is reduced to the minimum.

It should contain a single-seated lever starting valve. Double steam seats are difficult to keep in line, leak more quickly and are expensive to repair.

All valve seats subject to pressure should be heavily constructed and easily removable.

The overflow valve should be self-opening. It should not be subject to the pressure of the boiler; it should open freely if the injector "flies off." The heater cock should be convenient of access. All parts should be perfectly interchangeable.

PERFORMANCE.—No hand adjustment of the water supply should be required to prevent wasting, for any change of boiler pressure. It should operate at 15 lbs. steam and give its heighest capacity at or above the working boiler pressure. The minimum capacity should be at least 50 per cent. of the maximum, for there are few cases where a continuous feed is not the most economical, both for fuel consumption, and for the life of flues. It should be able to feed continuously with either a light or heavy train.

It should re-start automatically, for the water supply is liable to be temporarily interrupted by the swash of low water in the tender or by accidental adjustment of the feed below the minimum capacity. In either case the injector should reprime automatically. Further, automatic re-starting renders the action positive when running at night or when the injector is placed outside of the cab.

It should be economical in the use of steam, so that when the locomotive is heavily loaded, starting the injector will not pull down the boiler pressure. Starting a No. 10 injector reduces the tractive power from 95 to 150 h.-p., depending upon the design of the injector, tubes and nozzles.

When the steam pressure is 200 lbs., the injector should operate positively with a water supply at a temperature of at least 100 deg.; a still higher limiting temperature is advantageous, if the performance of the injector is not sacrificed.

Comprised under both the above heads is the wear of the internal parts; at 200 lbs. pressure, the velocity of the steam at the smallest part of its nozzle is 1,500 feet per second, increasing to 2,800 ft. per second at the terminal flare and reaching 3,847 ft per second at the time of impact with the water.

The cutting action of silt or dirt in the water supply is proportional to the velocity of the carrying jet, just as is the case with a polishing or abrading wheel. If the tubes are correctly designed, the converging and diverging curves corresponding to the lateral contraction and expansion of the jet, the longest service will be given. But to reduce the cutting action, it is obviously advantageous to maintain as low a velocity in the delivery tube as is consistent with the ability to feed the boiler; this can only be obtained when the minimum weight of steam is used by the injector per gallon of water delivered, and the amount of steam used can be measured by the temperature of the feed entering the boiler compared with that of the water supply. The higher the temperature of the delivery, the greater the excess of steam used, and the higher the velocity of the jet and consequent cutting action.

A table giving the relation of delivery temperature to the velocity of the jet is given below:

TABLE IV.

VELOCITY OF JET IN DELIVERY TULE, FOR TEMPERATURE OF BOILER FEED, STEAM PRESSURE 200 POUNDS, WATER SUPPLY 65°.

Temperature Boiler Feed.	Approxi'te Velocity.		Temperature Boiler Feed.	Approxi'te Velocity.	
	Ft. per Sec.	Ft. per Min.		Ft. per Sec.	Ft. per Min.
160	230	13,800	250	315	18,900
175	238	14,280	275	365	21,900
200	255	15,300	300	455	27,300
225	280	16,800	325	580	34,800

When it is remembered that the surface speed of a grinding wheel is only between 5,000 and 6,000 ft. per min., the enormous velocities noted in Table IV and the effect of abrasive foreign material in the water supply will be appreciated.

When the water supply contains lime-bearing salts, both the exterior and interior surfaces of the tubes become coated; however, if the tubes are continually submerged in cold water, the precipitation of scale is largely prevented. A properly designed nonlifting injector is very serviceable with water of this kind; during operation, water from the supply may be admitted directly to the overflow chamber and tubes; when shut off, closing the waste valve keeps the injector body flooded, condensing all leakage from the steam valve.

THE DELIVERY.

The delivery should be conducted through two check valves, the main check bolted or screwed to the boiler shell. This check is preferably supplied with a superimposed stop, to permit the complete withdrawal of the main check valve and its seat from the casing without reducing the pressure of the boiler. Secondly, a supplemental check, placed close to the injector. The reason for advocating a check valve in the pipe line is that with the present fixed standards of exterior dimensions of the injector and its branches, it is practically impossible to design a satisfactory valve at or near the delivery tube, and contained within the injector body, which will be convenient of access without breaking the delivery connection, or will be durable under high boiler pressures.

The delivery pipe need not be as large as the suction, as there is always ample forcing power in an injector to overcome a valve and pipe resistance of from 10 to 50 pounds counter-pressure. Where the water supply contains carbonate or sulphate of lime, it is advantageous to use a larger pipe, on account of the coating of scale which soon forms on its interior surface when the main check leaks.

WELDING LOCOMOTIVE FRAMES.

BY R. P. C. SANDERSON.

The first successful attempts to weld broken frames in place, that were given much publicity, were made on the Southern Pacific in California, following which the writer took up the idea and made many successful welds, using kerosene oil as fuel; gas can also be used very well. Each fracture requires its own detailed treatment; there can not be any text-book examples laid down for others to follow. There are, however, governing conditions that rule in every case that should be understood.

To get a welding heat quickly with the least possible wasting away or burning of the metal, the oil or gas flame must be regulated so that there is not quite enough air to give absolutely perfect combustion, to the end that there will be little or no free oxygen in the flame to oxidize the metal.

For the same reason the little furnace that must be built up and around the fracture to be welded should have only just space enough for the flame to whirl around the frame, give off its heat to the fire bricks and fire clay, which soak it up like a sponge soaks up water, without this flame being driven too hard against the metal, as this will cause wasting away. The inlet for the flame and its first contact with the metal should be at the back or unimportant part of the frame and not against a finished surface, that has been or must be machined, as the wasting away is greatest at first impact of the flame. There should be as little space between the metal to be heated and the furnace wall as will suffice, as the heating is done principally by the heat that has been soaked up by the bricks and is radiated back against the metal. Radiation loses force rapidly with increasing distance.

The outlet for the waste flame should be located where the man doing the job can watch the heat through it and see the weld, as a minute's extra heating is very wasteful.

No more of the frame should be heated than must be to get a good weld, seldom over 4 or 5 inches each side of the weld.

The furnace must be so built that a couple of quick blows of a sledge will knock it all down, clear out of the way, so that the smiths can sledge up the weld on the sides while yet at the serviceable heat. The pit can be partly full of water into which the red hot bricks fall.

A 4 by 5 frame can be brought to a welding heat in not to exceed twenty minutes, if the points just mentioned are thoughtfully observed.

When a weld is made in this manner the frame will of course be a trifle shorter and somewhat wasted away, which is objectionable. To avoid this it is best to jack the fracture apart and place between it ¾ inch of good high-grade soft hammered iron, the irregularity of the fracture will usually keep the surface more or less apart, which has the advantage of allowing the heat to penetrate between the broken surfaces. The soft iron between the broken parts heats first and acts as a cement, welding more easily on the broken surfaces than they will to one another.

To get a perfect weld, a thirty-ton hydraulic jack should be in place before the heat is started, so that when the metal is at welding heat it can be pumped up and force the broken surfaces together at its full power. To prevent the frame bending under this pressure it must be counterbraced, which is usually easy to do. By jacking the fracture together in welding, the surface around the weld is bulged out a little all around and after the furnace is knocked down while the pressure of the jack is still on, the two smiths can hammer away at the surfaces of the weld, leaving enough to chip or file down to a fair bearing for shoes or wedges, etc.

It is best to make some centerpunch marks in the frame well away from the weld on either side; have a tram made to fit these punch marks, allowing just a little for shrinkage for the final cooling off. These punch marks must be well outside of the furnace and the tram made to straddle it, then the tram can be

held in place while the jacking is done and the foreman can see when the weld has been sufficiently crushed together.

With skill and thought many a broken frame can be welded in place in this manner and give satisfactory service afterwards, but, if the frame is too weak in design at the broken place, it needs strengthening or it will break again. We can not add metal by welding as described but must resort to some other method.

THERMIT WELDING.—Here is where the recently invented and developed process of Thermit welding comes to our assistance and this permits repairs to be made and reinforcement to be made on broken frames in cases that could not be handled in any other known way.

The Thermit process is not a welding process in any sense of the word, but is a foundry process—casting process. The blacksmith has little or nothing to do with it; as a general proposition he should be kept out of it, as his life's training, his prejudices and his interests must naturally be in an entirely different direction.

Perhaps a history of the writer's experiences in learning to use Thermit successfully will serve as a guide for others who have not tried it, or show those who have had ill success with it how they can reach success.

Profiting by the experience of a disappointed neighbor, we did not make any attempt to weld engine frames at first.

The first thing done was to make a few small casts of Thermit; study its temperature and action on small sections of iron and steel.

Following this we took some short broken sections of old frames and laid them in a mold on the foundry floor and attempted to mend the fractures by Thermit.

Following the usual prescription given us at that time by the manufacturers, the first cast was made and the result appeared to be a first-class job; however, bearing in mind the trouble our neighbors had had, the piece of metal was taken and put in a planer and sliced from end to end, exposing the core or center of the weld. One-half of this was polished on the emery wheel on the guide grinder, and this showed—while bright—that the molten steel from the Thermit had welded itself on to the partly fused stub ends of the old frame, but in cooling off had shrunk by natural contraction, leaving a number of cavities, like blow holes, in the center, which very materially weakened the section at that point.

It was found that this metal was exceedingly hard and brittle, while the rest of the frame was of the usual soft hammered wrought iron, consequently we had a hard, brittle, spongy knot in the middle of the bar of soft iron.

The other half of this sample was heated in the furnace and drawn out under the steam hammer. It drew down to about one-half of the original section and then broke in two, right through the old fracture and through the center of the Thermit. The fracture showed that the break had occurred through these shrinkage cavities or blow holes.

Study of the proposition indicated clearly that some method of forcing the broken fracture together, after the cast had been made, and during the process of cooling off, and while the metal was still at welding temperature, was necessary, to close up the spongy holes—in other words the shrinkage must be followed up in order to get solid metal. Another advantage of this would be that instead of the particles of the molten steel cooling off in the form they assume in a steel casting—in other words, in a crystallized condition—that this crushing together would in a measure produce a similar result to a subsequent forging process, in that it would knead or squeeze the congealing metal and make it more ductile.

To prove the correctness of this reasoning, a fresh sample was prepared and fresh cast was made with it in precisely similar manner to the first cast, but after pouring the cast the two ends of the frame were forced together with jacks a distance of a little over ⅛ of an inch.

The result justified our belief. The cavities were very much fewer and much smaller, and crushed together, so that they represented flaws or lines rather than holes. It was evident that the crushing together process had not been undertaken soon enough, or with sufficient pressure to properly weld up these shrinkage cavities. It was also noticeable on the fractures, after polishing, that there was rather a definite line of demarcation at the junction where the cast steel had burned on to the wrought iron, and in cutting it, it was noticed that when the tool went through the soft iron and came up against the hard Thermit there was a distinctly different resistance, indicating still a hard knot in the middle of the soft frame.

The other half of this section, after being sliced, was drawn out under the steam hammer at a higher temperature than the first cast, and drew down to less than one-third of the original section before fracture took place, and this again showed breakage through the shrinkage cracks of cavities.

It was evident that our processes were not right yet, and since Thermit steel by its own nature must necessarily be a more dense and harder metal than any wrought-iron or cast-steel frame could usually be, it becomes necessary to figure out some way in which the line of demarcation between the Thermit, which is manganese steel, and the wrought iron, forged or cast-steel frame could be obliterated and be made more gradual, otherwise cracks would be sure to finally come in these frames at the point where this sudden change of quality in the material existed.

After much thought we decided to drill the ends of the frames at the fractures, choosing the size of the drills used to suit the size of the section; thus, as it were, making a series of dovetails in the two ends of the fractured frame, into which the liquid Thermit could be poured and interlock even though the welding might not be perfect. It would also do away with the sharp distinction between the Thermit steel and the soft metal of the original frame.

A third sample was prepared along these lines, and in view of the necessity of forcing it together more than was previously done, the original fractures were separated by small pieces of soft iron about ⅜ inch. The cast was made, and as quickly after the heat and flame and burning slag would permit the sections were jacked together until they resumed the original length between previously located center marks, which meant that the Thermit metal had been compressed ⅜ of an inch after pouring.

This weld showed a very distinct advance over the others. The cuff around the weld was swelled out, due to the jacking process.

When this sample was examined it showed at the section that the junction between the Thermit steel and the original metal was less clearly defined; there were only a few small spots or specks which would indicate shrinkage cavities.

The other half of this section drew down to about one-fourth size without any fracture, except a few small ragged surface cracks at the corners, and we felt that we had succeeded in developing a process which we could rely on to give satisfactory results.

One thing which was noticeable at once in the last experiment, which we had not thought of before, was shown by the polished fracture; the Thermit had melted off the ends of the dovetails. The conclusion to be drawn from this was obvious; that with such an arrangement as high a temperature as we had been experimenting with, with pure Thermit, was not necessary, and if anything objectionable, so that we added to the following test a proportion of boiler punchings in the Thermit, thus cheapening the process, and as the intense temperature of the melted Thermit was partly used in melting this additional quantity of steel punchings the result was the temperature of the molten metal was reduced; the character of the Thermit metal after cooling off was different, in that it had not been so suddenly chilled and was less brittle, which was an additional advantage gained by this new method.

Feeling confident of practical success we then proceeded to weld broken frames, following the lines of these last experiments, and have been, with two exceptions, successful.

To help toward certainty in the weld we arranged the Thermit mold around the fracture with an opening in the bottom for a gas or oil flame and, just as if we were going to make a flame weld in place, the frame and inside of the mold were heated until brought up to a bright cherry red, after which the hole in the bottom of the mold was quickly closed and made secure with a dry sand plug luted in and backed with sand and the Thermit touched off.

By doing this the Thermit was not chilled by a mass of cold frame; it did not require to be robbed of so much of its heat to fuse the heavy frame ends and a larger proportion of punchings could be used successfully, thus greatly cheapening the work. This preheating of the mold is of great importance.

To reinforce a weak place the usual cuff that is cast around the weld can be extended or thickened, making the weak place stronger than before the break.

There are of course plenty of places about locomotive frames where fractures may occur where Thermit can not be used, on account of the cuff interfering with attachments, but in many such cases we have chipped off such portion of the cuff as interfered and let the balance of it go, in other cases the presence of the boiler mud-ring or other parts up against the frame prevented the use of Thermit. Of course, Thermit can not be successfully used at the frame splices and in a few other places, and where it is just as easy to make an ordinary weld by means of a small furnace built around the frame as it is to use Thermit the ordinary weld is preferable and cheaper.

SPECIAL VALVE GEARS FOR LOCOMOTIVES.

INDIVIDUAL PAPER BY MR. C. J. MELLIN.

Pursuant to the request of the Committee on Subjects to present a paper on special valve gears, as the Walschaert, Allfree, Young, etc., I beg to submit the following, based on the understanding that it includes only such gears as are applicable to locomotives.

As several gears in use on locomotives are derivations from others not suitable for locomotives, it may in a few cases be of advantage, however, to go back to the origin from which they are developed, and others referred to as comparisons in being applicable but do not possess sufficient advantages for acquiring any extended adoption.

GOOCH VALVE MOTION.

Among the latter class may be mentioned the Gooch, or stationary link motion, which might be said to be the opposite of Stephenson motion, in that the valve rod or link block is raised and lowered in reversing the engine, instead of the link in the latter. It is operated with two eccentrics set in the same relation to the crank as in Stephenson's gear, and the link is curved to a radius equal to the length of the valve rod or radius bar and turned with its convex side to the axle. This motion gives a constant lead and has otherwise no advantage over the Stephenson gear, except, possibly, that the link block and the radius bar are lighter to lift in reversing than the link; but it presents an objectionable feature in that the sweep of the radius bar in its raising and lowering is obstructed by the front driving axle when the main connection is made to the second or third pair of wheels, and is probably the principal reason why the Gooch gear has been in little use and is now practically abandoned altogether in locomotive service.

ALLAN VALVE MOTION.

The Allan motion may be said to be a combination of the Stephenson and Gooch gear, as the link and valve rod are both moved in opposite directions, so that the angularities and distances

in either direction are reduced to one-half of those in either of the other motions under comparison with an increase of lead amounting to about one-half of that obtained by the Stephenson gear in linking up the engine. For this reason the Allan gear has been the favorite valve motion in continental Europe for a generation or more.

With properly selected lengths of lifting arms of the reverse shaft the link is made straight instead of curved as in the previous cases, which, in manufacturing in former days, was of no little importance in its favor. The lifting arms are placed on opposite sides of the reversing shafts, which is necessitated by the required opposite vertical motion of the link and valve rod in changing the cut-off or reversing the engine and thereby practically balancing each other and holding the reversing shaft in an approximate equilibrium at any position of the reversing lever.

These are all properties of considerable advantage over either the Stephenson or Gooch gears.

Although the Allan motion is the most correct one in existence it has never gotten any foothold in America, probably for the reason that it has to some extent the same objectionable feature as the Gooch in regard to the front driving axle, which, however, is not serious, as the short vertical sweep of the valve rod admits of a bend or a yoke for straddling the axle. As this motion is located inside the frames and occupies about the same place and is of the same weight as the Stephenson gear, on modern engines it would be heavy and cumbersome to apply, so its introduction at this time is hardly to be looked for. These conditions have also made themselves manifest in Europe, and the Allan gear, in spite of its excellent qualities, is fast disappearing from modern locomotives, being displaced by the more advantageous construction and application of the Walschaert motion, which will be referred to later.

The Stephenson, Gooch and Allan motions can be classified as one system in that they are all based on the two eccentrics set in symmetrical relation to the line of motion, one governing the forward and the other the backward movement of the engine, differing principally only in the matter of lead. In the Gooch gear, with its constant lead, it makes little difference if the rods are crossed or open, but in the Allan and Stephenson it is important that the rods are always open so that there is no reduction of lead in linking up, as crossed rods will reduce the port opening at the earlier cut-off and cause an unfavorable wire-drawing of the steam.

HACKWORTH VALVE MOTION.

There are various kinds of valve motions that are driven with a single eccentric, among which the oldest probably is that of John Wesley Hackworth, which was designed sometime between 1840 and 1850, and while this type in its original form is not suitable for locomotives, it is referred to as the starting point for a number of modifications, of which a few will be presented, in the line of its evolution to fairly good valve motions for locomotives under various names of so-called "radial" gears.

In 1879 Mr. Joy applied this gear with a slight modification to a locomotive engine and it is therefore generally known as Joy's gear. It is largely used in Russia and to some extent in several other countries without having gained any predominating use over the Allan motion which, as said before, until a few years ago was the general favorite in continental Europe. The Joy gear is probably the highest development of the Hackworth motion adaptable to locomotives and gives a very good steam distribution when properly fitted up, but the effect on the movement of the valve by the vertical play of the main axle on a rough track is not entirely eliminated.

In this arrangement, as well as in the original, and in fact in all modifications of the Hackworth gear, the link block or combination lever fulcrum can be guided by a curved frame ("link" as it has been called on account of its similarity to the ordinary reversing links), or by a swinging link and arm of approximately the same length as the radius bar where such a construction is applicable.

No principle of valve motion has been so fascinating and subject to so many varieties of construction as that of Hackworth, and a score or more inventors have, with comparably small modifications, found them meritorious enough to connect them with their names.

WALSCHAERT MOTION.

The most suitable form of radial gear for locomotives is unquestionably the one invented by the Belgian engineer, Egide Walschaert, in 1844, and applied to locomotives a few years later, but it was not properly understood or appreciated during the first twenty years following its invention, and has ever since then made slow headway until a few years ago, when it took quite a sudden move forward and is at present the dominating valve gear throughout the continent of Europe, and is rapidly gaining ground in this country, where, only within the last two years, it has been applied to engines for regular road service, although it has been in use in sundry cases, principally small engines. This gear may be said to be based on a fundamental principle of its own, but has also been subject to a few modifications without any improvement over its original form.

The motion of the valve is derived from two sources, namely, the main crank by connection to the crosshead, and from an eccentric placed approximately at right angles to the main crank. The crosshead connection imparts the motion of lap and lead at the extremities of the stroke of the piston, at which moment the link is in its central position. Therefore in the midgear with the reverse lever in its center notch this will be all the motion imparted to the valve and the radius bar becomes stationary. The link is curved to a radius equal to the length of the radius bar. By moving the reverse lever forward the eccentric motion is brought into combination with the motion from the crosshead, producing a valve opening for the forward motion of the engine, and by moving the reverse lever backward the link block is brought to the opposite side of the link fulcrum, resulting in a valve opening governing the backward motion of the engine, in effect similar to that of the Stephenson motion. The action of this one eccentric is therefore the same as if it was two eccentrics, one for forward and one for backward motion, placed diametrically opposite each other, and the angle of advance in the Stephenson motion is taken care of by the main crank in the crosshead connection. The latter motion being constant, it follows that the lead remains constant at all points of cut-off.

The proportions of the various parts of the Walschaert gear cannot be determined experimentally, nor should any change in setting the valves be made unless the effect of the change is known in advance. It is therefore important that the different parts should be made and set correctly from the beginning and there will then be no need for changes when the original dimensions are maintained. The difference in this gear for outside and inside admission valves must be considered in setting the eccentric crank and as the forward motion of the engine should preferably be taken from the lower end of the link when the eccentric crank will *follow* the main crank for *inside* admission valve, and *lead* the main crank for *outside* admission valve. The connecting point of the radius bar to the combination lever is *above* that of the valve stem connection for *inside* admission and *below* the valve stem connection for *outside* admission valves. The desired maximum cut-off, lead and valve travel determines the size of the lap, and thereby the lap and lead motion are obtained by the corresponding proportioning of the combination lever.

GENERAL NOTES FOR ADJUSTING WALSCHAERT GEAR.

1. Ascertain by the following method the position of the eccentric crank: Mark the position of the link relative to its middle position on both of the dead centers of the main crank. If the position of the link is the same in both cases the eccentric crank position is correct, if not the eccentric crank should be shifted until this occurs or as near so as possible.

2. After the eccentric crank has been correctly set the eccentric rod should be lengthened or shortened as may be required to bring the link in its middle position so that the link block can be moved from its extreme forward to its extreme backward position without imparting any motion to the valve. It may be noted that the link position may be observed by the usual tram marks on the valve stem, or direct by marks on the link pin as may be found most convenient with the link block in full gear, preferably ahead.

3. The difference between the two positions of the valve on the forward and back centres of the engine is the lap and lead doubled; it is the same in any position of the link block and cannot be changed by changing the leverage relations of the combination lever.

4. The tram marks of the opening moments at both ends of the valve should be marked on the valve stem and the latter lengthened or shortened until equal leads at both ends are obtained.

5. Within certain limits this lengthening or shortening may be made on the radius bar, if it should prove more convenient, but it is desirable that its length should be so nearly equal to the radius of the link that no apparent change in the lead should occur in moving the link block as stated in note No. 2.

6. The lead may be increased by reducing the lap and the cut-off points will then be slightly advanced. Increasing the lap produces the opposite effect on the cut-off and reduces the lead the same amount. With good judgment these quantities may be varied to offset the irregularities inherent in transforming rotary into lineal motions.

7. The valve events are to a great extent dependent on the location of the suspension point of lifter of the rear end of the radius bar, when swinging lifter is used, which requires that this point should be properly laid out by careful plotting, or, if convenient, it is preferably determined by a model, as irregularities due to incorrect locus of this point cannot be corrected by the other parts of the gear without more or less distortion of same. When this point is so fixed that a change of same is impracticable it may be better, however, to modify other elements if thereby the motion in general can be improved.

The chief point of difference between the Walschaert and Stephenson gear when both are in proper condition is, as previously stated, that the former gives to the valve a constant lead at all cut-offs, whereas the latter produces an increase of lead by linking up the engine which becomes excessive at short cut-offs. This very point has been the subject for much controversy and has probably done more than anything else to retard the progress of the use of Walschaert gear; as it has been argued that in full gear, when the speed generally is slow only small lead is needed, but at higher speed more lead is required, which is accomplished by the Stephenson motion, though this admittedly becomes excessive at early cut-offs, causing considerable compression and preadmission detrimental both to maintenance and to smooth running, and, in fact, to some degree counteracts the work done by the steam on the driving side of the piston, which thereby also affects the speed of the engine.

It was gradually discovered that the required lead for short cut-off and high speed was of no practical detriment to the working of the engine in full gear as the preadmission at that point is disappearingly small. The proper amount of lead, however, is dependent somewhat on the service, and the port opening becomes larger with a larger lead, or, in other words, when all other conditions are equal in a Stephenson or Walschaert gear the openings differ by the same amount as the lead, so that 1-16 in. more lead gives 1-16 in. wider port opening; but it is hardly advisable to make this over ¼ in. or 5-16 in. as a maximum, as the advantage of any additional port opening by means of a larger lead is more than off-set by the increase in compression and preadmission the larger lead would bring about at early cut-offs, and would do no good in the later cut-offs even if it does not do any harm.

There is no fundamental reason that the Walschaert gear should produce any economy in steam consumption over the Stephenson motion when both are in the best condition, but an advantage in

this respect comes to the former by the fact that it remains in its good condition if once made so, from one shopping to another, and is therefore on an average more economical both in steam consumption and maintenance of the gear than the latter. The accessibility for attention is a great point of undisputed advantage of the Walschaert gear which is also highly appreciated by the enginemen and attendants.

It will be borne out in the course of time that the bracing between the frames permitted by the Walschaert gear will bring about a considerable reduction in the maintenance expenses by the less wear and tear this additional rigidity will impart to the entire engine.

HELMHOLTZ MODIFICATION.

Among the various modifications of the Walschaert gear the one made by Helmholtz is probably of some advantage. This modification consists in making the link straight and the radius bar is connected to the lifting link instead of the link block. The curving of the link is compensated for by the reversing shaft or lifting arm fulcrum being located in a given position above the link so that the locus of the suspension point of the lifting link forms an arc of a circle with its chord perpendicular to the center line of the radius bar in its center position. The radius of this arc bears the same relation to the length of the radius bar as the distance of the radius bar connection above the link block bears to the length of the lifting link, which results in that this connection is moving in an arc with a radius of the length of the radius bar and the same motion of the valve is obtained as in the direct Walschaert gear.

Two advantages may be claimed for this modification, of which one is the straight link being simpler to make than the curved one, and the other is that on large piston valve engines with inside admission the link fulcrum can be lowered by the amount the radius bar connection falls over the link block, whereby the eccentric connection rod can be brought closer to the center line of the axle with less length of link and eccentric throw. It has, however, the disadvantage that there is little choice in the location of the reversing shaft or lifting arm fulcrum, a proper position for which is hardly obtainable on all types of engines and admits of no other method or lifting the radius bar in linking up or reversing the engine.

ALLFREE-HUBBELL GEAR ATTACHMENT.

The Allfree contrivance is an attachment to the ordinary Stephenson motion by which the valve is given a symmetrically irregular motion, causing it to open and close quickly, and is of special importance at high speed and early cut-off. The effect of this movement is about the same as what would be accomplished with a valve with extraordinarily long valve travel, but with a somewhat delayed exhaust and compression. The general construction of this device consists in substituting for the knuckle pin joining the valve stem to the rocker arm a small crank shaft, to which crank the valve stem is connected and the shaft left free to revolve in the rocker arm bearing. To this shaft a pinion is keyed engaging a toothed wheel sector oscillating on the rocker shaft by means of a lever connection from the crosshead. This gives a composite motion to the valve; namely, one direct from the eccentrics and one from the crosshead transmitted by the rotation of the crank on the knuckle pin shaft in such a way that the two motions coincide at the opening and closing moments, but are in opposition at the extreme travel of the valve, when the latter is nearly at a standstill, while the main crank passes through a comparatively large angle with a uniformly open port, and the closing of the valve is rapidly accelerated in the same manner as the opening, causing a quick and sharp cut-off. The exhaust and compression are similarly affected by this alternating, accelerating, and retarding motion of the valve, delaying the exhaust and compression even at early cut-offs. The advantage is, as already stated, greatest at high speed when a relatively high average pressure is obtained, which again is dependent on the capacity of the boiler. It is quite complicated to attach, especially on certain types of engines when the driving wheels are straddled by the guide yoke and thereby limiting the space required for the rocker arms and bearings.

YOUNG VALVE ARRANGEMENT.

This gear consists chiefly in the application of the Corliss valves to the locomotive engine with one valve both for the steam inlet and the exhaust at each end of the cylinder. Each valve is provided with double admission and exhaust ports. The steam ports are practically opposite each other, and the relation of the edges of the ports in the valve to these ports corresponds to that of the valve edges to the steam ports of the ordinary slide valve, forming the steam laps, lead and exhaust laps or clearances as the case may be. The exhaust cavity is a passage diametrically through the valve of sufficient width on one side to combine both steam ports with the main exhaust port simultaneously during the exhaust period. At right angles to the exhaust passage is a similar but somewhat larger cavity which corresponds to the steam chest with transverse passages through the valve body alternating with the exhaust passages, and the lap and exhaust edges are surrounded by carefully fitted slats, both on sides and ends to prevent leakage.

The motion is transmitted through a pivoted wrist plate to the valve from an ordinary Stephenson valve motion. By means of pivoting the wrist plate on the arm of a bell crank whose other arm is connected with a union rod to a short arm on the reverse shaft, the wrist plate is raised and lowered by the motion of the reverse lever producing a moderate increase in lead, an earlier exhaust and later compression than the direct Stephenson motion produces in linking up the engine.

The main advantage of this valve is the quicker admission, closing and exhaust it accomplishes due to the double port openings, and the small resistance it offers to the valve motion, as compared with the slide valve, in being completely balanced. In common with the Allfree gear it gives a higher average pressure at high speeds than the ordinary valve. This gear, as well as in the previous case, involves additional complications over the ordinary gear, requiring special skill, both in its manufacture and adjustment, which to some extent counterbalances the abovenamed advantages.

There are a few more modifications of various kinds which have not reached any adoption beyond the experimental stage before they were dropped out of existence and they are not of sufficient importance to be taken into consideration in this paper, in which only the most suitable gears for locomotives have been selected, and it is hoped that the few points referred to will furnish material for a discussion of fuller description of results in service from which valuable conclusions may be drawn.

PERSONALS.

Mr. C. B. Cramer, master mechanic of the Southern Railway at Sheffield, Ala., has resigned.

Mr. W. F. Moran has been appointed master mechanic of the Southern Railway at Sheffield, Ala.

Mr. E. L. Burdick, master mechanic of the Wabash Railroad at Decatur, Ill., has been transferred to Bluffs, Ill.

Mr. J. B. Young has been appointed chemist of the Philadelphia & Reading Railroad, succeeding Mr. Robert Job, resigned.

Mr. G. P. Robinson has been appointed inspector of locomotive boilers by the State Board of Railroad Commissioners of New York.

Mr. D. C. Courtney has been appointed superintendent of motive power of the Coal & Coke Railway, with headquarters at Elkins, W. Va.

Mr. D. P. Morrison has been appointed electrical engineer of the Pittsburgh & Lake Erie Railroad, succeeding Mr. G. M. Campbell, resigned.

Mr. F. K. Kraemer has succeeded Mr. C. A. Braun as master mechanic of the St. Louis, Iron Mountain & Southern Railway shops at Baring Cross, Ark.

Mr. M. S. Curley has been appointed superintendent of motive power of the Sierre Railway Company of California, with headquarters at Jamestown, Cal.

Mr. C. E. Paul, foreman of the erecting department, has been made general foreman of the Tilton shops of the Wabash Railroad, succeeding Mr. E. M. Hughes, transferred.

Mr. H. C. Kiesschas has left the service of the Buffalo, Rochester & Pittsburg Railway to become chief air-brake inspector of the Chicago, Rock Island & Pacific Railway.

Mr. J. H. Farmer has been appointed master mechanic of the Mexican Division of the Chicago, Rock Island & Pacific Railway at Dalhart, Tex., succeeding Mr. E. D. Andrews.

Mr. E. F. Tegtmeyer, foreman of the Fort Wayne, Ind., erecting shops of the Pennsylvania Lines West, has been appointed assistant superintendent of C., R. I. & P. shops at East Moline, Ill.

Mr. James Farrell, acting superintendent of motive power and machinery of the National Railroad of Mexico, has been appointed superintendent of motive power and machinery, with office at Laredo, Tex.

Mr. Joseph Chidley has been appointed master mechanic of the Lake Shore Division of the Lake Shore & Michigan Southern Railway, with headquarters at Collinwood, Ohio, vice Mr. S. K. Dickerson, promoted.

Mr. C. L. Bundy, general foreman of shops, Delaware, Lack-

awanna & Western Railroad, has resigned to accept a position as manager of the car department of the Hicks Locomotive & Car Works, Chicago.

Mr. G. M. Reynolds has been appointed master mechanic of the Alliance Division of the Chicago, Burlington & Quincy Railway, with headquarters at Alliance, Neb., vice Mr. E. W. Fitt, assigned to other duties.

Mr. Francs W. Webb, for many years chief mechanical engineer of the London & Northwestern Railway, and the designer of the Webb four-cylinder compound locomotive, died at Bournemouth, England, on June 4th.

Mr. E. D. Andrews, master mechanic of the Chicago, Rock Island & Pacific Railway at Dalhart, Tex., has been appointed to the new office of master mechanic of the Arkansas & Louisiana divisions, with office at Little Rock, Ark.

Mr. E. B. Thompson, master mechanic of the Chicago & Northwestern Railway shops in Winona, Minn., has been appointed second assistant superintendent of motive power for the entire system, with headquarters in Chicago.

Mr. S. K. Dickerson has been appointed assistant superintendent of motive power of the Lake Shore & Michigan Southern Railway, with headquarters at Cleveland, Ohio, vice Mr. L. G. Parish, resigned to accept service with the Michigan Central Railroad Company.

Mr. LeGrand Parish, formerly assistant superintendent of motive power of the Lake Shore & Michigan Southern Railway, has succeeded Mr. Bronner as superintendent of motive power and equipment of the Michigan Central Railroad, with headquarters at Detroit, Mich.

Mr. E. D. Bronner, superintendent of motive power and equipment of the Michigan Central Railroad, has been appointed superintendent of motive power of the Lake Shore & Michigan Southern Railway, with headquarters at Cleveland, Ohio, in place of Mr. Ball.

Mr. Herman L. Delo, assistant chief motive power clerk of the Pennsylvania Railroad at Altoona, and for 52 years in the company's service, has been retired on a pension. Mr. Delo enjoys the unique record of never having lost a day's pay during his long term of employment.

Mr. James H. Crawford, foreman of the machinery department of the Wabash Railroad at Peru, Ind., has been transferred as general foreman of the shops at Decatur, Ill. Mr. Crawford has been succeeded by Mr. Edward Schwartz, formerly assistant general foreman of the Erie shops at Huntington, Ind.

Mr. H. F. Ball has resigned as superintendent of motive power of the Lake Shore & Michigan Southern Railway to accept a position with the American Locomotive Company as vice-president in charge of the automobile department. Mr. Ball has been with the Lake Shore & Michigan Southern Railway since 1890, and has been superintendent of motive power since February, 1902.

BOOKS.

The Railroad Manual Appendix and Diary. Sixth Annual Number, 283 pages. Published by Poor's Railroad Manual Co., 68 William St., New York.

This book contains complete information concerning railroad bonds and stocks for the use of bankers, investors, trust institutions and railroad officials. This edition contains several new features not given in previous issues, including the statistics of steam and street railways in the U. S. and a table of gross earnings by months for leading roads from 1900 to 1905.

The Car Builders' Dictionary, 1906. An illustrated vocabulary of terms which designate American railroad cars, their parts, attachments and details of construction. With definitions and illustrations of typical British practice in car construction. Compiled for the Master Car Builders' Association by Rodney Hitt, under the supervision of the following committee: C. A. Seley, H. F. Ball and J. E. Muhlfeld. Published by the *Railroad Gazette*, 83 Fulton Street, New York. Price, $6.00.

This is the fourth revised edition of the Car Builders' Dictionary since its first publication in 1879. The first edition was seven years in preparation, and five years after it was published it was necessary to revise it for the first time. The second revision was made in 1895, and eight years later the third revision was issued in 1903. During the last three years changes in the design and construction of cars has been even greater and of a more radical nature than during any of the periods intervening between the previous revisions. This is particularly so in respect to the wide use of steel for freight cars and the beginning of its general use for passenger cars. Steel cars of both kinds, and in a large variety, are included in this edition. A comparison of the pages of this and the 1903 edition will show that nearly half of the former engravings have been replaced by illustrations of new and improved devices, and that nearly 200 pages of illustrations have been added, giving a total number of illustrations in this edition of 6,344. The general arrangement, with some minor changes which it seemed proper to make, has been preserved. In view of the early publication of the Locomotive Dictionary, along similar lines, all references to devices and parts of devices belonging directly to the locomotive or tender have been eliminated, and considerable matter in reference to typical British cars has been added in this edition, which will give a good general idea of the dimensions and principal constructive features of the standard designs of cars used in Great Britain. The revision of the definitions has been made with a view of eliminating superfluous and obsolete matter and changing the wording of the definition of such terms as has gradually taken on a new meaning, and the addition of others which have come into general use during the past few years. Our readers who are familiar with the earlier editions will no doubt lose no time in securing copies of this revision, which brings the matter of car construction strictly up to date. To those who do not know the book it is only necessary to say that it affords a liberal education in the subject of modern car construction and the standards of the M. C. B. Association. Only the best and approved practice is included, and that is shown to the fullest extent.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

Direct Current Generators.—The Fort Wayne Electrical Works, Fort Wayne, Ind., is issuing a bulletin descriptive of a direct connected direct current type of generator for power and lighting. This generator is carefully described in detail, the description being supplemented by illustrations of important parts.

Book of Babbitt Metals.—The More-Jones Brass & Metal Company, St. Louis, is issuing a small catalog, showing its large variety of special grades of babbitt and anti-friction metals for different kinds and conditions of bearings. Each metal has a separate paragraph stating the uses for which it is specially adapted. Prices are given.

Oil Engines.—The DeLaVergne Machine Company, 138th Street, New York, is issuing an attractive catalog thoroughly describing and illustrating the Hornsby-Akroyd oil engine, which is constructed in practically any size desired. The catalog illustrates and briefly describes a large number of recent interesting applications, including several which drive the dynamos for furnishing the light for government lighthouses. The engine is shown in portable forms driving air compressors, dynamos, etc.

Electric Apparatus.—The Emerson Electric Mfg. Company, St. Louis, is issuing a number of new bulletins briefly describing several new designs of electric machinery. One of these is a small type of motor driven air pump suitable for small users of compressed air. Another one shows small bi-polar enclosed motors with capacities of from 1-20 to 1-5 h.-p. These are also shown arranged with a worm gear speed reduction device. Direct current motors are also shown in small sizes with a worm gear speed reduction device.

SECOND-HAND METAL WORKING MACHINERY.—The Niles-Bement-Pond Company, 111 Broadway, New York, is issuing list No. 12 of second-hand metal working machinery, which includes 60 pages giving a brief description of the 300 different machines which they have on hand and are offering for sale. These machines are in many cases practically as good as new.

ELECTRIC-AIR ROCK DRILLS.—The Ingersoll-Rand Company, 11 Broadway, New York, is issuing an illustrated catalog descriptive of a new type of rock drill which has recently been perfected. This consists of an air drill in its simplest form, without valves, which is operated through two hose connections from a simple air compressor direct connected to an electric motor. Each set is mounted on a small car to run upon the mine tracks. Cable connections are carried to the motor, and the drill is operated directly by the compressor through the short hose connection. The catalog illustrates and describes this apparatus very completely.

INCANDESCENT MANTLE LAMPS FOR PINTSCH GAS.—The Safety Car Heating and Lighting Company, 160 Broadway, New York, has recently issued a catalog of standard size which shows a large number of illustrations and drawings, including numbered and named parts of a wide variety of styles for incandescent mantle lamps for passenger car lighting with Pintsch gas. These are shown with side brackets for single lights and with the center brackets for any desirable number of lights, arranged either for gas exclusively or in connection with electric light fixtures. It is stated that these mantels will give from 10 to 12 weeks' service and that they increase the candle power of the Pintsch gas more than three times.

G. E. ELECTRICAL APPARATUS.—The General Electric Company has recently issued a number of bulletins descriptive of the latest development and newest designs of different electrical apparatus. One of these illustrates and describes completely the G. E. 87 railway motor, which embodies the latest improvements in railway motor design. Another bulletin treats in a similar manner the direct current Curtis steam turbine generator sets of the horizontal type. These are made in sizes from 15 k.w. to 300 k.w., and can be operated either condensing or non-condensing. Other bulletins describes motor driven air compressors, type H subway transformers and small polyphase motors.

STEAM HEATING.—The Safety Car Heating and Lighting Company, 160 Broadway, is issuing a standard size catalog which includes a number of large plates illustrating the heating system for passenger cars, using either steam direct or the "standard system," which is a steam heating system in connection with the Baker heating system, the latter being installed in its usual manner, and the heating of the water and its circulation obtained by means of steam jackets placed at several points in the circuit; these jackets are heated by steam from the locomotive. Both of these systems are very completely described and illustrated, and the catalog includes illustrations of a large number of supplies used in connection with steam car heating.

RECORDS OF RECENT CONSTRUCTION, NOS. 56 AND 57.—The Baldwin Locomotive Works has recently issued the two last numbers of the "Record of Recent Construction." No. 56 is entitled the "Atchison, Topeka and Santa Fe Railway System," and confines itself exclusively to the illustrating and describing of locomotives on this system in an historical manner, showing the progress from the small early engines to the latest freight, passenger and switching locomotives. The record of the Scott special, which covered 2,265 miles in less than 45 hours actual time, with a train weighing 170 tons behind the engine, is given very completely, including reference to the illustrations of the locomotives used on each section. No. 57 is entitled "Common Standard Locomotives of the Associated Lines," and illustrates and describes in detail the different standard locomotives and parts adopted last year by the Harriman Lines, which were shown very completely in the AMERICAN ENGINEER. The locomotives are illustrated and much interesting matter concerning them is included in the pamphlet.

NOTES.

S. SEVERANCE MANUFACTURING COMPANY.—In the advertisement of this company, appearing on our front cover, the name of Mr. H. C. McNair as northwestern agent, was inserted by mistake in our July issue.

CHICAGO CAR HEATING COMPANY.—This company opened an eastern office at 170 Broadway, New York City, on July 1st. Messrs. F. F. Coggin and B. A. Keeler have been placed in charge of this office.

NEW SHOPS.—The Cincinnati Milling Machine Company, Triumph Electric Company, Cincinnati Planer Company and the Bickford Drill & Tool Company have jointly purchased a plot of about 100 acres of land at Oakland, Ohio, a suburb of Cincinnati, where it is expected they will erect new and larger shops the first of next year.

DAYTON PNEUMATIC TOOL COMPANY.—The recent report to the effect that the plant of the Dayton Pneumatic Tool Company, at Dayton, Ohio, had been destroyed by fire was an error. We are advised that the fire caused but small damage, which was quickly repaired, and that the plant resumed operation with a full force with only three days' delay.

CROCKER-WHEELER COMPANY.—The San Francisco agent of this company writes that while affairs are still in a very unsettled state and that he is not absolutely sure whether the number will be changed in from six months to a year, he considers that their office is located at 206 First Street, and that that address will be used until further announcement.

PAINT SHOP DRYING APPARATUS.—The new paint shop of the New York, Ontario & Western R. R. Co., Middletown, N. Y., is to be provided with a heating and paint drying apparatus consisting of fan, heater and distributing system, to be furnished by the B. F. Sturtevant Co., of Boston, Mass. Experience with this type of installation in other shops has shown a very material reduction in the time required to dry off cars after painting.

ALLIS-CHALMERS COMPANY.—The Allis-Chalmers Company of Milwaukee, who recently acquired exclusive rights to build and sell the Christensen air brakes, is busily engaged in organizing a new department for the extensive manufacture of this well-known device. These brakes will be manufactured in Milwaukee by the new department under the managership of Mr. J. H. Denton, who will be surrounded by a staff of men specially trained in this branch of work.

NILES-BEMENT-POND CO., BOSTON OFFICE.—The Boston offices of Niles-Bement-Pond Company and Pratt & Whitney Company have been removed from Pearl Street to more spacious and handsomely furnished quarters on the eighth floor of the Oliver Building, corner of Milk and Oliver Streets. The policy of these companies is to dispense with showrooms, the variety of both heavy and light machine tools and cranes built by their several works being too great to permit of exhibition.

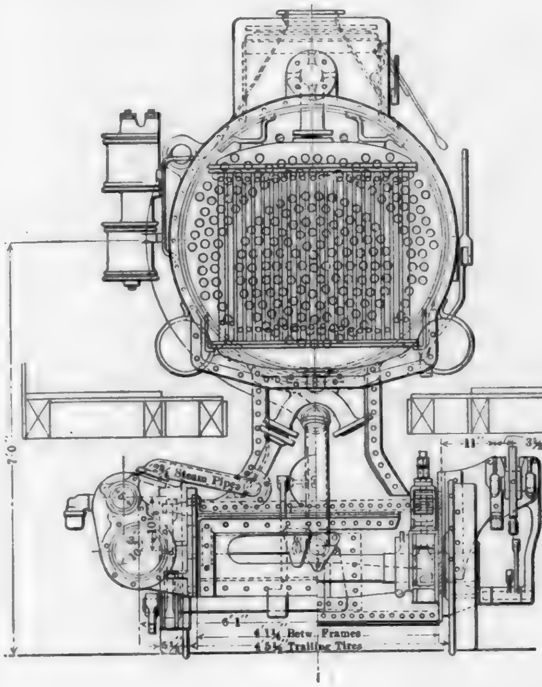
NEWTON MACHINE TOOL WORKS.—The death of Mr. Charles C. Newton, founder and president of the Newton Machine Tool Works of Philadelphia, which was announced in our last issue, made it necessary to elect new officers of that company. The following men, who have been closely associated with Mr. Newton for many years, have been chosen: President, Mr. Harry W. Champion; treasurer, Mr. William M. Graham, and secretary, Mr. Ellis J. Hannum.

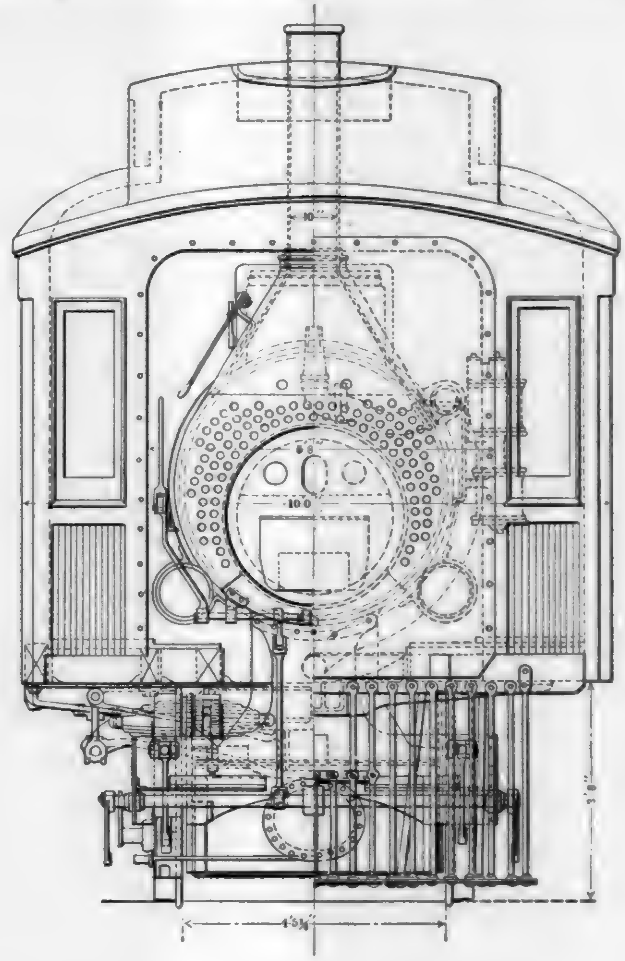
BARRETT JACKS IN NEW YORK CITY.—The Duff Manufacturing Company, of Allegheny, Pa., has opened an office in the Havemeyer Building at 26 Cortlandt Street, New York City, and have leased a warehouse within easy reach of this office where a complete line of Barrett and Duff roller bearing jacks will be kept in stock. Mr. Geo. A. Edgin is in charge of this office, and it is stated that patrons of this company in the vicinity of New York City will find it more convenient to send their orders and inquiries direct to this new office, which is now in a position to ship promptly.

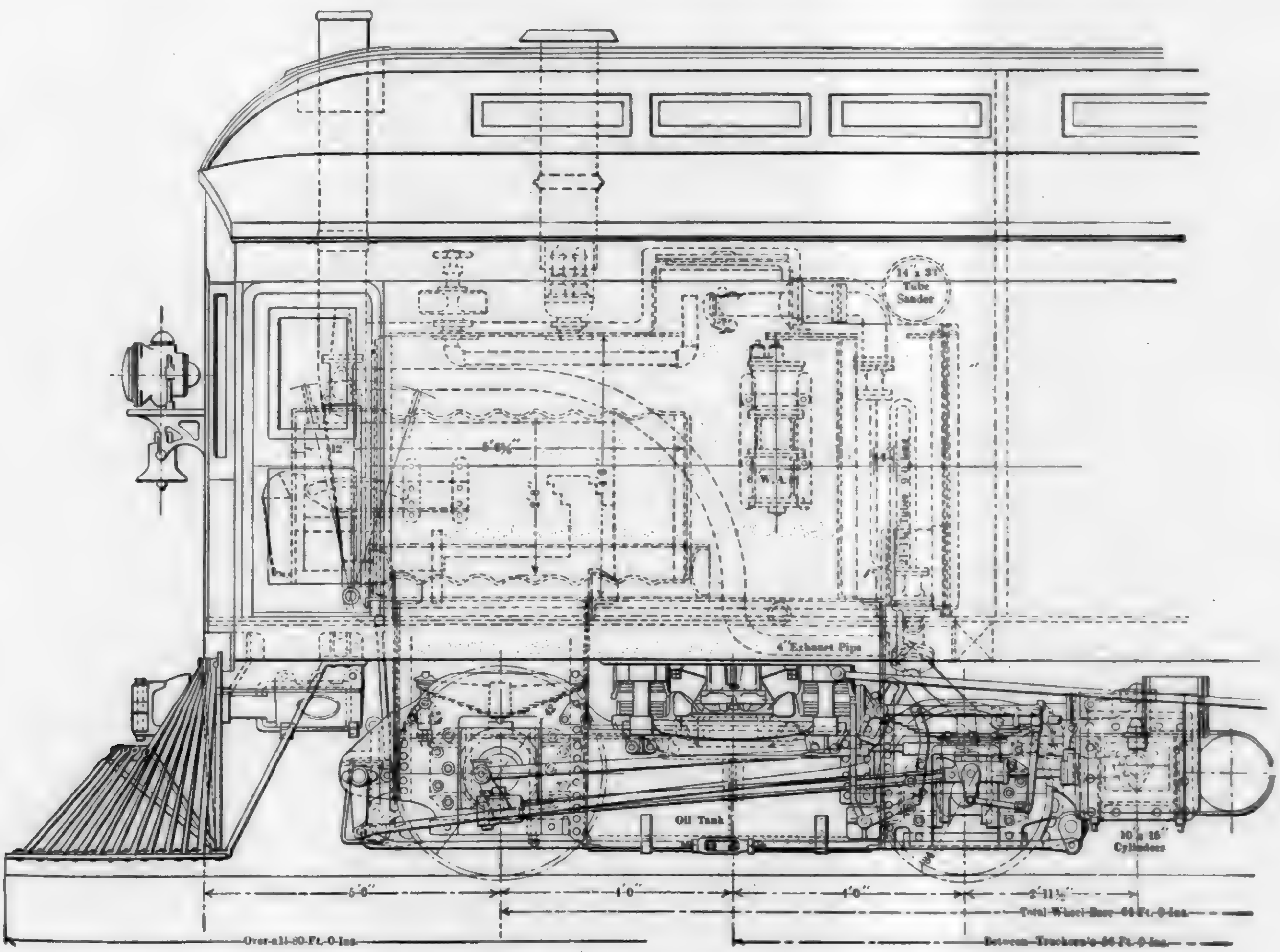
EXHIBIT OF THE RIVERSIDE METAL COMPANY.—This company had a very interesting and complete exhibit of its product at the Atlantic City conventions, where were shown a full line of manufactured and ingot metals in phosphor bronze, German silver and other compositions of copper. These metals were exhibited in all shapes and forms, from the raw material to the finished product, in sheets, rods, wire, tubing, rope and castings, as well as passenger car fittings in white metal. This company has recently made a considerable addition to its plant and is in a position to handle large orders with reasonable notice.

(Established 1832.)
AMERICAN
ENGINEER
AND
RAILROAD JOURNAL

SEPTEMBER, 1906.







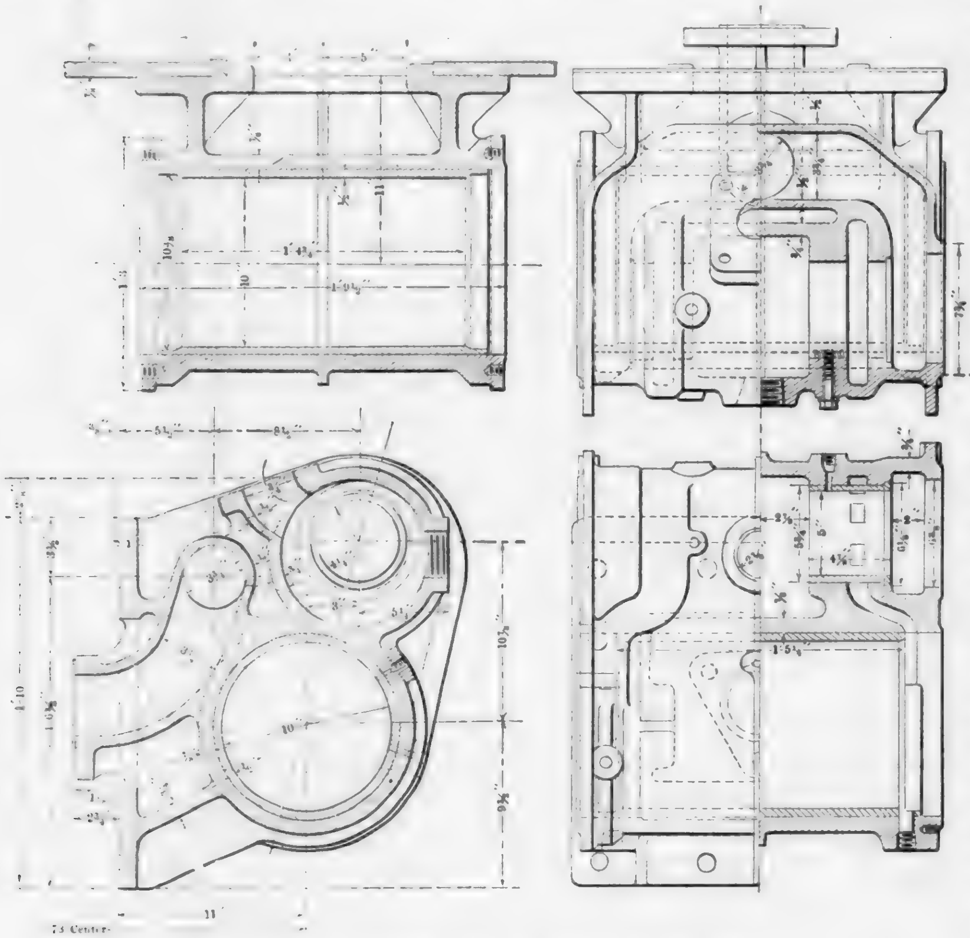
ENGINE ROOM AND DRIVING TRUCK OF STEAM MOTOR CAR—CANADIAN PACIFIC RAILWAY.

STEAM MOTOR CAR.

CANADIAN PACIFIC RAILWAY.

In the August issue, page 294, we presented a general description of the steam motor car, which was recently placed in operation on the Canadian Pacific Railway. We are fortunate in being able to present the details of the engine room arrangement, driving truck and frame, boiler and cylinders, in this issue. As shown on the floor plan, the car has an engine room, 13 ft. $7\frac{1}{2}$ ins. in length; a baggage room, 7 ft. 6 ins. long; a smoking room, 12 ft. 3 ins. long, with a seating capacity for 16 persons, and a main compartment, 30 ft. 9 ins. long, with a seating capacity for 40. In order to run the car with the rear end first, a small compartment is placed at the left side of the rear end, which is equipped with an engineer's brake valve, signal valve, air valve for bell ringer, and a telegraph attachment similar to that used between the bridge and the engine room of a steamship. By means of the telegraph the motorman or engineer may be signalled as to when to stop or start, whether to go forward or backward, and the speed at which it is desired to move the car.

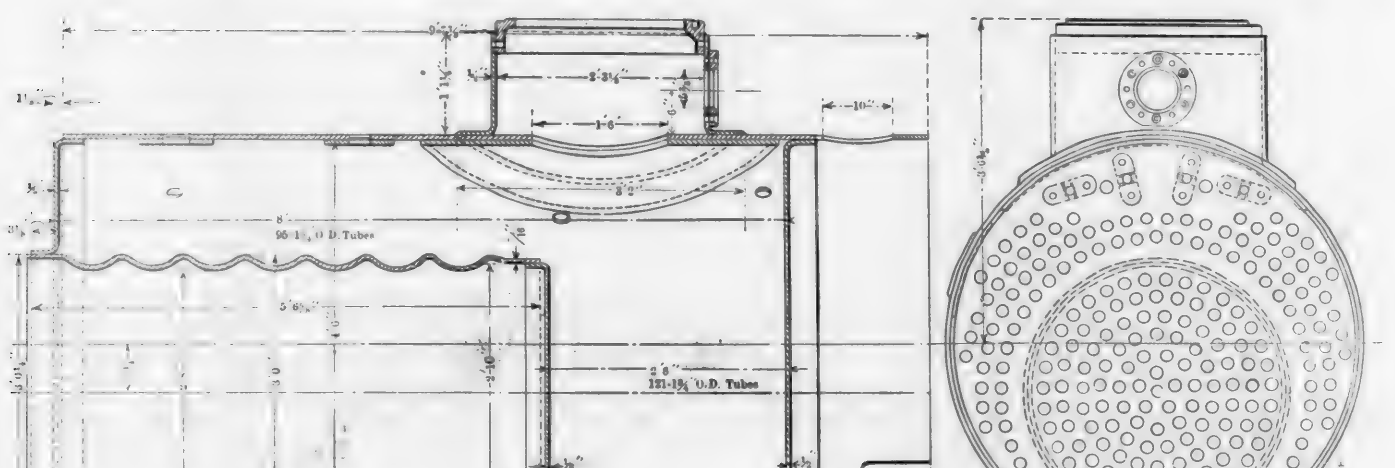
The boiler is supported directly on the frame of the driving truck, and is independent of the car body. This necessitates a rather unique construction for the truck and body bolsters. The elliptical springs, which carry the weight of the car body, rest on top of the side plates of the truck frame at either side of the body bolster. Parallel to the bolster are two steel castings, one on either side, which are supported by the springs, and from the ends of which hangers are suspended which support the cast steel truck bolsters. The body bolster is also of cast steel. The design of the center plates is somewhat different from that ordinarily used, the projection on the body bolster being much longer and of greater diameter. Susemihl side bearings are used.



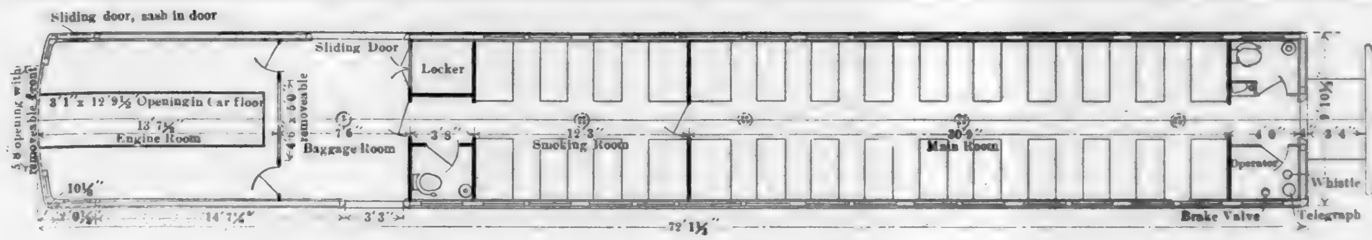
DETAILS OF CYLINDERS USED ON STEAM MOTOR CAR.

The driving truck frame is constructed of plates and rolled shapes, the arrangement of which is clearly shown on the drawing. The cylinders are bolted to an extension of the frame at the rear. A crude oil tank, with a capacity of 2,000 gals., is constructed in and forms the cross bracing of the truck frame.

The brick-lined Morrison corrugated tube furnace, 32 ins. in diameter and 5 ft. $6\frac{5}{8}$ ins. long, is equipped with a 1-in. slot burner, of the Booth type, and with an automatic blower and oil feed device. The boiler, of the return tubular type, is equipped with 95-1¾-in. tubes, 8 ft. long, and 121-2 ft. 8 ins. long. Boiler feed water to the amount of 900 gals. is carried in 3 tanks, suspended under the



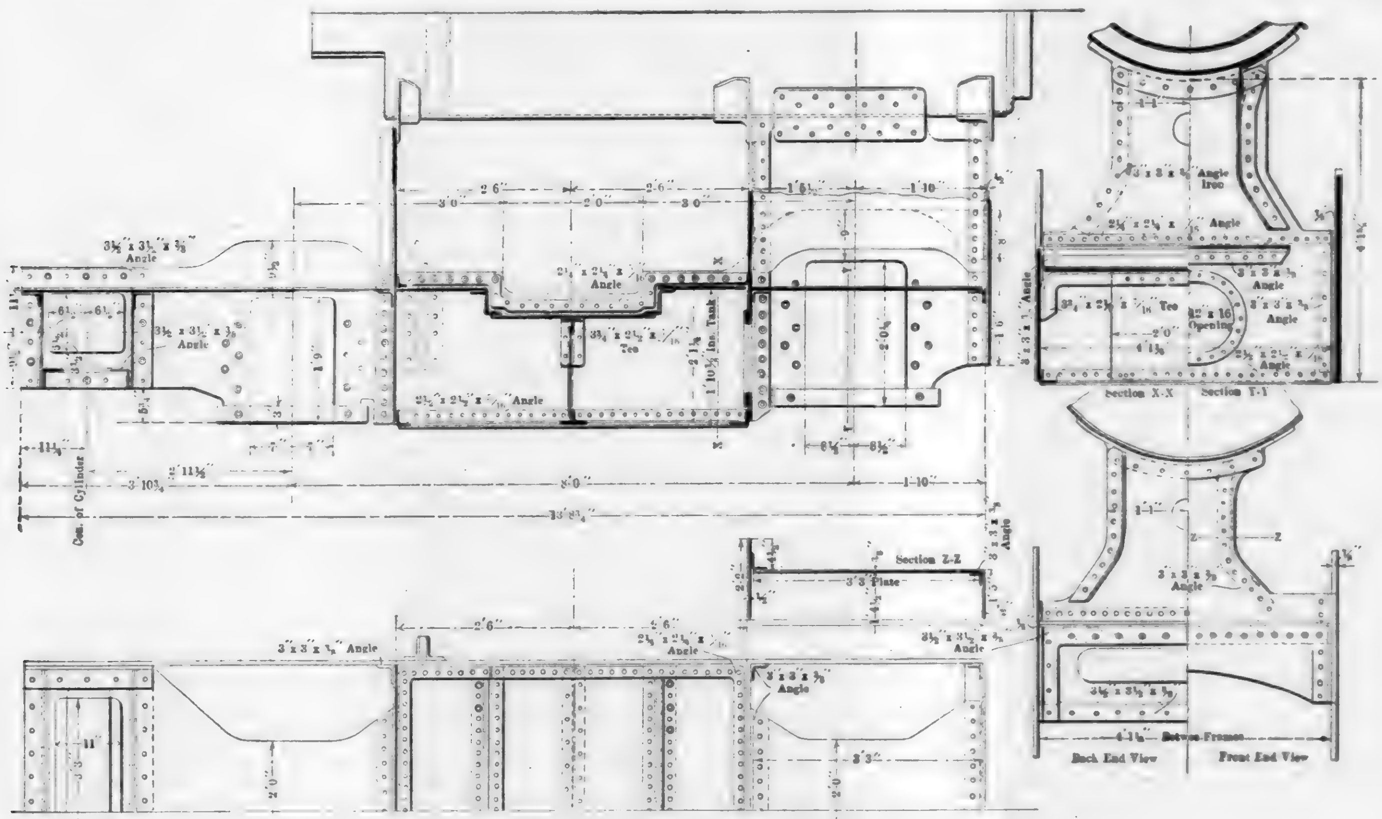
BOILER—STEAM MOTOR CAR—CANADIAN PACIFIC RAILWAY.



PLAN OF STEAM MOTOR CAR—CANADIAN PACIFIC RAILWAY.

body of the car. The smokebox is equipped with a superheater containing 21– 1¼-in. tubes, 9 ft. long, the arrangement of which is clearly shown on the general drawing. Steam passes from the side of the steam dome through the superheater in the smokebox and through the 2¾-in. steam pipe to the piston valve in the cylinder casting. The exhaust steam passes through a 4-in. pipe between the frames and up alongside the boiler to the smokestack at the front end of the car. A special stack or intake is placed above and encloses the safety valves to carry away the steam.

The cylinder castings are of comparatively simple design, and are bolted to the side plates of the truck frame, and in addition are keyed to the plates by taper keys 5 ins. long. The inside admission piston valve is operated by a simple design of Walschaert valve gear.



DRIVING TRUCK FRAME—STEAM MOTOR CAR—CANADIAN PACIFIC RAILWAY.

The leading dimensions and data are as follows:

Total weight	136,600 lbs.
Weight on leading truck	82,880 lbs.
Weight on drivers	42,440 lbs.
Weight on trailers	40,440 lbs.
Weight on rear truck	53,720 lbs.
Total wheel base	64 ft.
Distance between truck centers	56 ft.
Wheel base of driving truck	8 ft.
Length of car body	72 ft.
Length over all	80 ft.

CYLINDERS.

Diameter	10 ins.
Stroke	15 ins.

VALVES.

Style	Piston
Diameter	5 ins.
Greatest travel	3½ ins.
Steam ports	⅞ ins.
Lap, steam	⅝ ins.
Lap, exhaust	....
Lead	3-16 ins.
Valve gear	**Walschaert**

WHEELS.

Driving, number	2
Driving, diameter	42 ins.
Trailing, diameter	34 ins.
Rear truck, diameter	36 ins.
Journals, driving	8 by 12 ins.
Journals, trailing	7 by 12 ins.
Crank pins	3 by 4 ins.

BOILER.

Type	Horizontal, internal fire, return tubular
Working pressure	180 lbs.
Temperature, superheated steam	700-760 deg. F.
Diameter, outside	4 ft. 7 ins.
Firebox, diameter	34 ins.
Firebox, length	5 ft. 6⅝ ins.
Tubes, number and length	121-2 ft. 8 ins. / 95-8 ft.
Tubes, diameter	1⅜ ins.
Heating surface, tubes	485 sq. ft.
Heating surface, firebox	51 sq. ft.
Heating surface, total	536 sq. ft.

SUPERHEATER.

Tubes, diameter	1¼ ins.
Tubes, number	21
Tubes, length	9 ft.
Superheater, surface	62 sq. ft.

GENERAL.

Fuel, crude oil under a constant air pressure of 15 lbs. per sq. in.—capacity of tank	2,000 gals.
Water storage capacity	9,000 gals.

ATTACHMENTS.

Slot burner, Booth type, 1 in.
Hancock, type A, injector with No. 5 body and No. 5 tubes.
Hancock, type A, injector with No. 5 body and No. 3 tubes.
Detroit 4—feed lubricator.
Oil tank pressure reducing valve.
Westinghouse schedule A.M.T. automatic air-brake.
Eight-inch air pump.
Telegraph attachment.
Air-brake controlling valve at rear end of car.
Acetylene lighting.
Little Giant bell ringer.
Air chime whistles.

ENGINE DEFINED.—The revised book of train rules defines "engine" as "a locomotive propelled by any form of energy."

CONSOLIDATION LOCOMOTIVE EQUIPPED WITH ALLFREE-HUBBELL CYLINDERS AND VALVES—ROCK ISLAND SYSTEM.

CONSOLIDATION LOCOMOTIVE WITH ALLFREE-HUBBELL CYLINDERS AND VALVES.

CHICAGO, ROCK ISLAND AND PACIFIC RAILWAY.

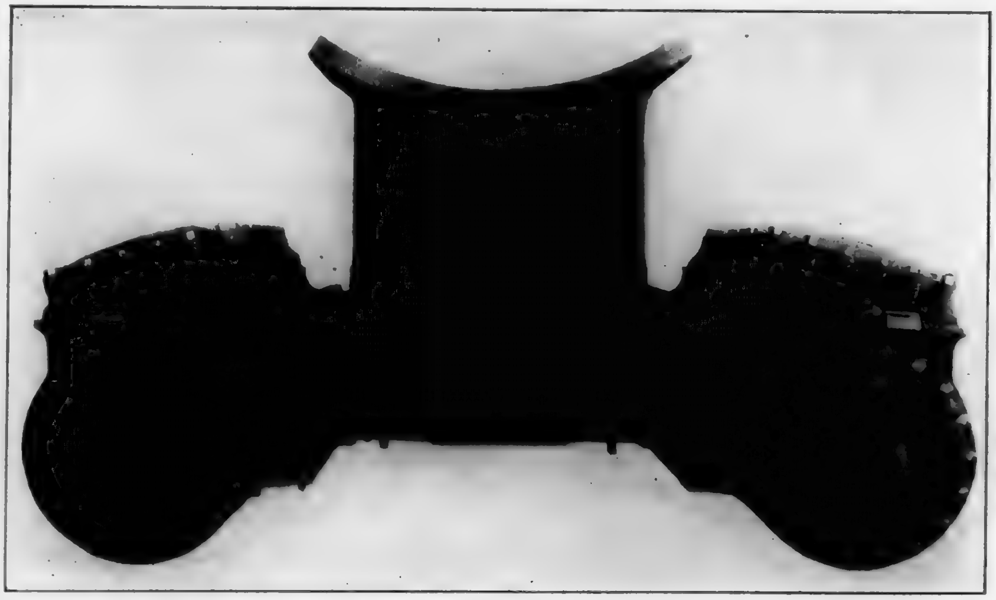
Early in 1903 the Chicago, Rock Island & Pacific Railway received from the Brooks Works of the American Locomotive Company an order of more than 100 consolidation freight locomotives. These engines were illustrated in the AMERICAN ENGINEER AND RAILROAD JOURNAL in March, 1903, page 106, and special mention was made of the excellence of the design of the valve gear and piston valves. Since being put into operation they have proved themselves to be all that was expected and have given very satisfactory service during the past three years, being operated in heavy freight service under the many varied conditions found on a large system like the Rock Island.

The motive power department of this road desiring recently to test in a practical manner the merits of the latest design of the Allfree-Hubbell valve gear equipped one of the locomotives of this class, No. 1676, with cylinders and valves furnished by the Locomotive Appliance Company of Chicago. This engine was then placed in service alongside of a regular standard engine of the same type, No. 1687, and the two engines were run single-crewed for 60 days in service west from Valley Junction, Iowa. The test began the 1st of April and ended the 1st of June, 1906. The crew which handled No. 1687 during April ran No. 1676 during May, while the crew of the latter ran the former, thus eliminating personal equation from the test. A careful record was made of the tonnage, amount of coal burned and cost of running repairs. Each engine made 26 trips, and at the end of the test it was found that No. 1676 had handled 1,479 or 5.29 per cent. more tons of freight and had consumed 32 tons or 11.07 per cent. less coal, and that the pounds of coal consumed per 100 ton miles had been 2.458 or 14.63 per cent. less, and the repairs 2.38 per cent. less on this engine.

This practical test on two locomotives which were identical in every respect except cylinders and valves, would indicate that the better distribution and more economical use of steam in the Allfree-Hubbell design had a most satisfactory result on the tonnage hauled and the cost of operation of the locomotive.

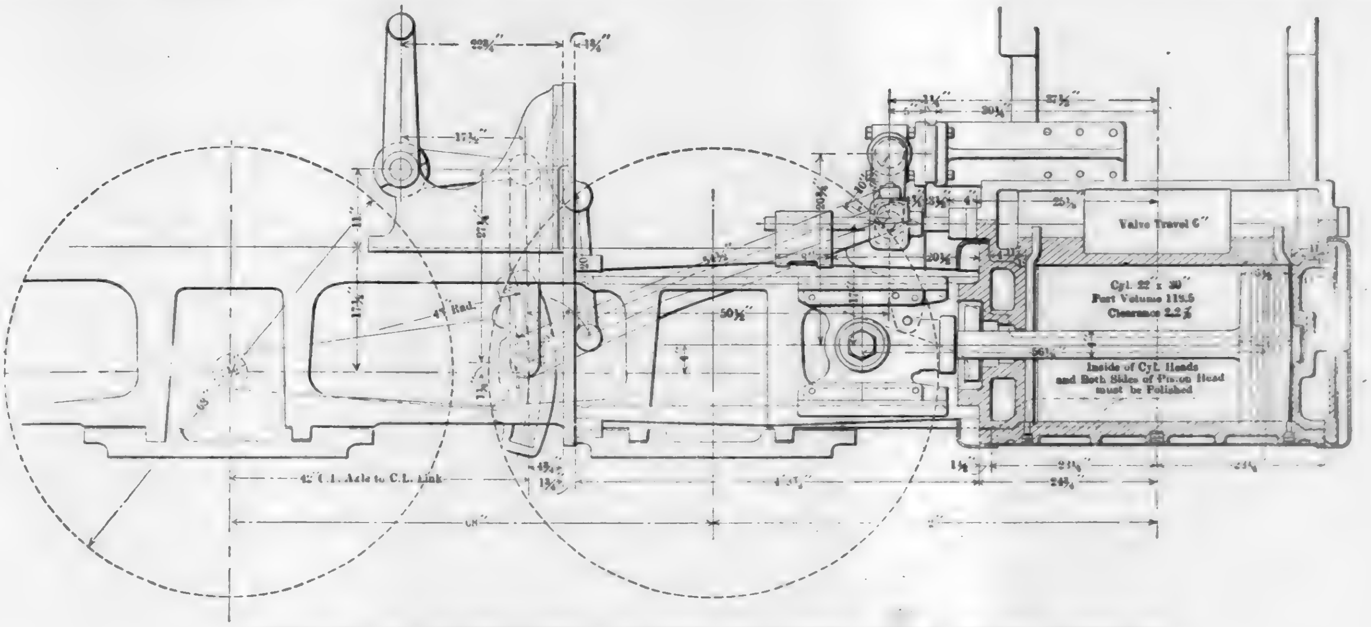
The difference in the steam distribution between the two engines lies principally in the fact that with the Allfree-Hubbell valves the point of both exhaust opening and closure is later in the stroke, and that the opening for the release of the exhaust steam is larger, allowing the cylinders to very rapidly free themselves. There are also other differences in the cylinder which undoubtedly had an effect upon the economy obtained, such as much shorter ports, the separation of the live steam and the exhaust passages in the cylinder casting, the polished surface of ports, pistons and cylinder heads and the insulation of the steam chest cover, as will be seen in the illustration of these cylinders.

The earlier designs of the Allfree-Hubbell valve gear employed the use of a geared sector operated from the cross head, which had a supplementary effect upon the movement of the valve proper by means of an eccentric connection at the rocker arm. In the latest design, however, this outside attachment has been eliminated and the valve is connected directly to the valve stem, operated by either the ordinary Stephenson or Walschaert valve gear and has no complications outside of the cylinder.

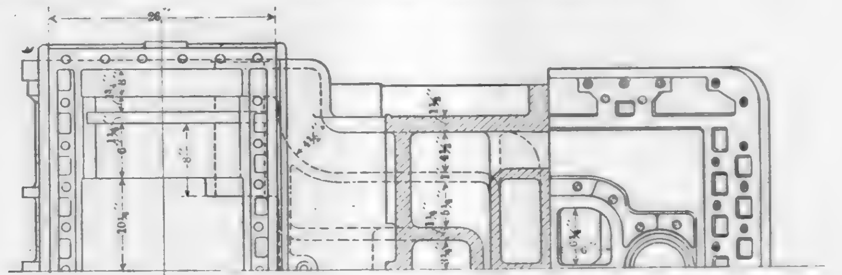


ALLFREE-HUBBELL CYLINDERS READY FOR APPLICATION TO LOCOMOTIVE.

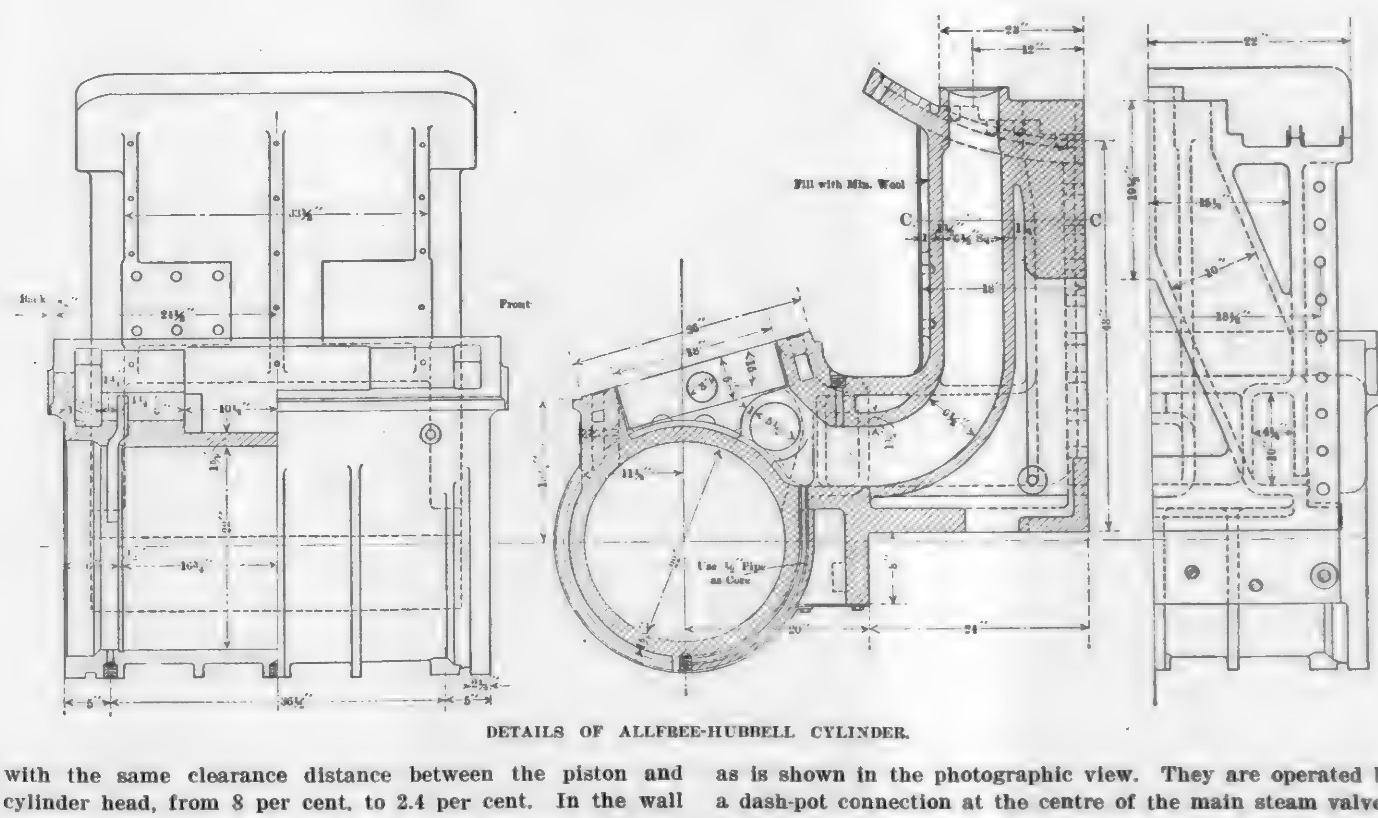
An examination of the illustrations will show the methods used for attaining the results and refinements mentioned above. It will be seen that the valve seat and valve are located at an angle of 15 deg. with the transverse horizontal, and that the space between the cylinder and the valve seat is much less than usual, which taken in conjunction with the very direct steam ports has reduced the amount of clearance,



APPLICATION OF ALLFREE-HUBBELL CYLINDERS AND VALVES TO ROCK ISLAND LOCOMOTIVE.



Section C.-C.



DETAILS OF ALLFREE-HUBBELL CYLINDER.

with the same clearance distance between the piston and cylinder head, from 8 per cent. to 2.4 per cent. In the wall between the cylinder port and the exhaust passage, just below the inner side of the valves, there are openings 5½ ins. in diameter which are bushed and fitted with valves. These compression controlling valves, as they are called, are simple piston valves with wide rings, and are carried in bushings pressed into place and fastened in the opening. They are guided at either end by an extension of the valve stem fitting into housings bolted on the outside of the cylinder, as is shown in the photographic view. They are operated by a dash-pot connection at the centre of the main steam valves. This dash-pot connection is so arranged as to give these supplementary valves such a movement as will make them open simultaneously with the exhaust edge of the main valve, but will retard their closing until the main valve has moved about 1¼ ins. over the exhaust port, thus giving over 23 sq. ins. exhaust opening after the exhaust closure of the main steam valve, and closing it at about 90 per cent. of the stroke in short cutoffs.

CONSOLIDATION LOCOMOTIVE EQUIPPED WITH ALLFREE-HUBBELL CYLINDERS AND VALVES.—ROCK ISLAND SYSTEM.

CONSOLIDATION LOCOMOTIVE WITH ALLFREE HUBBELL CYLINDERS AND VALVES.

Chicago, Rock Island and Pacific Railway.

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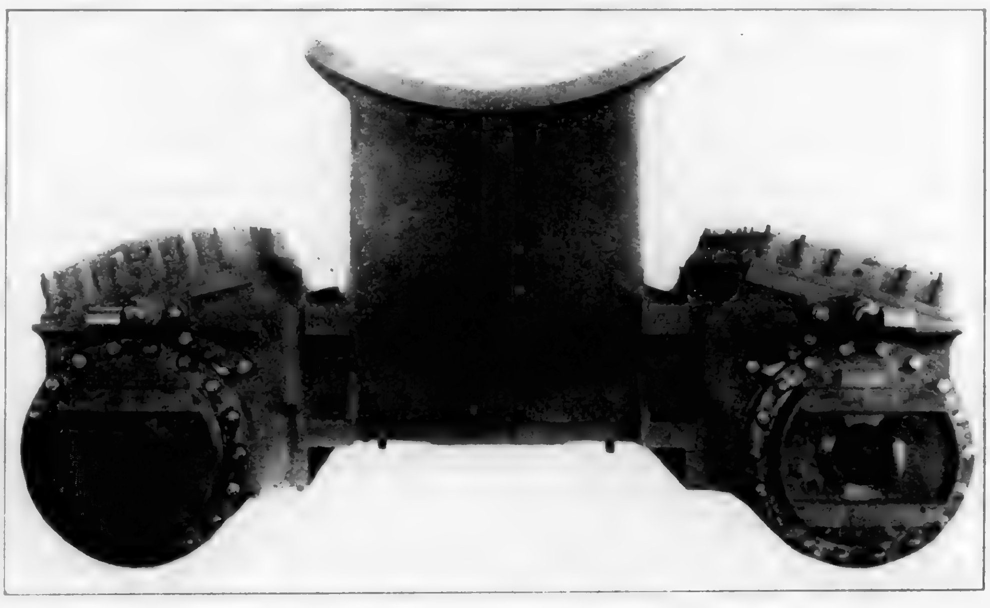

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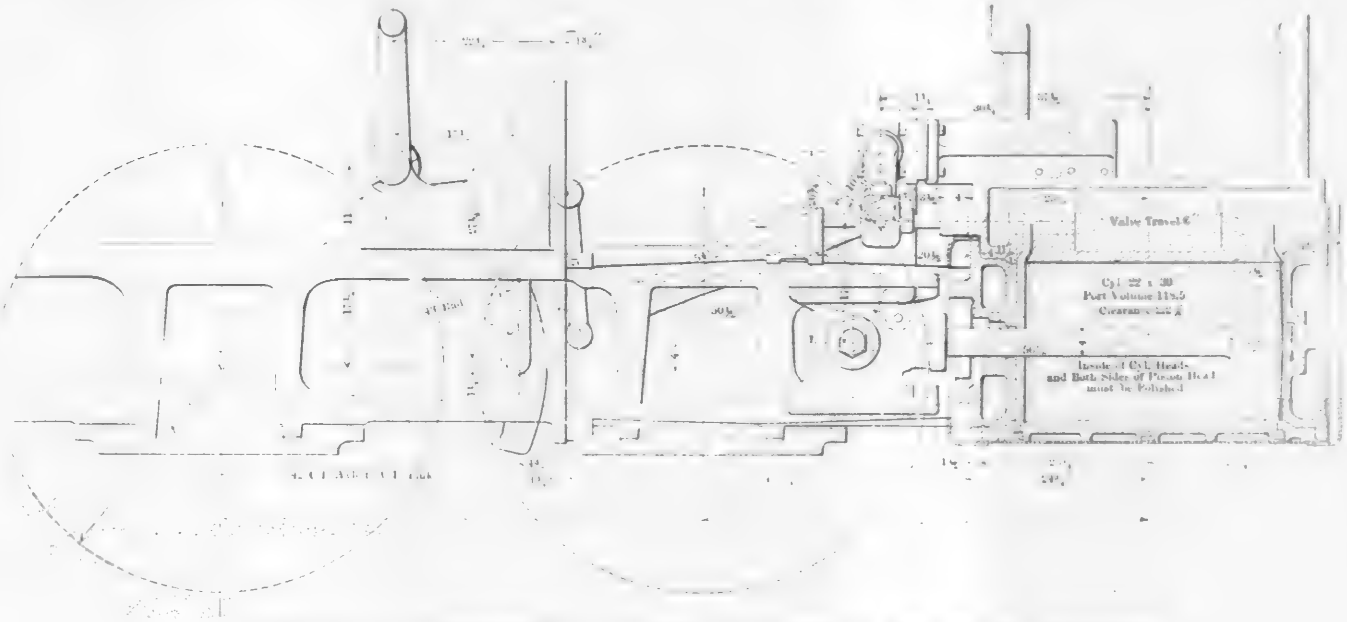
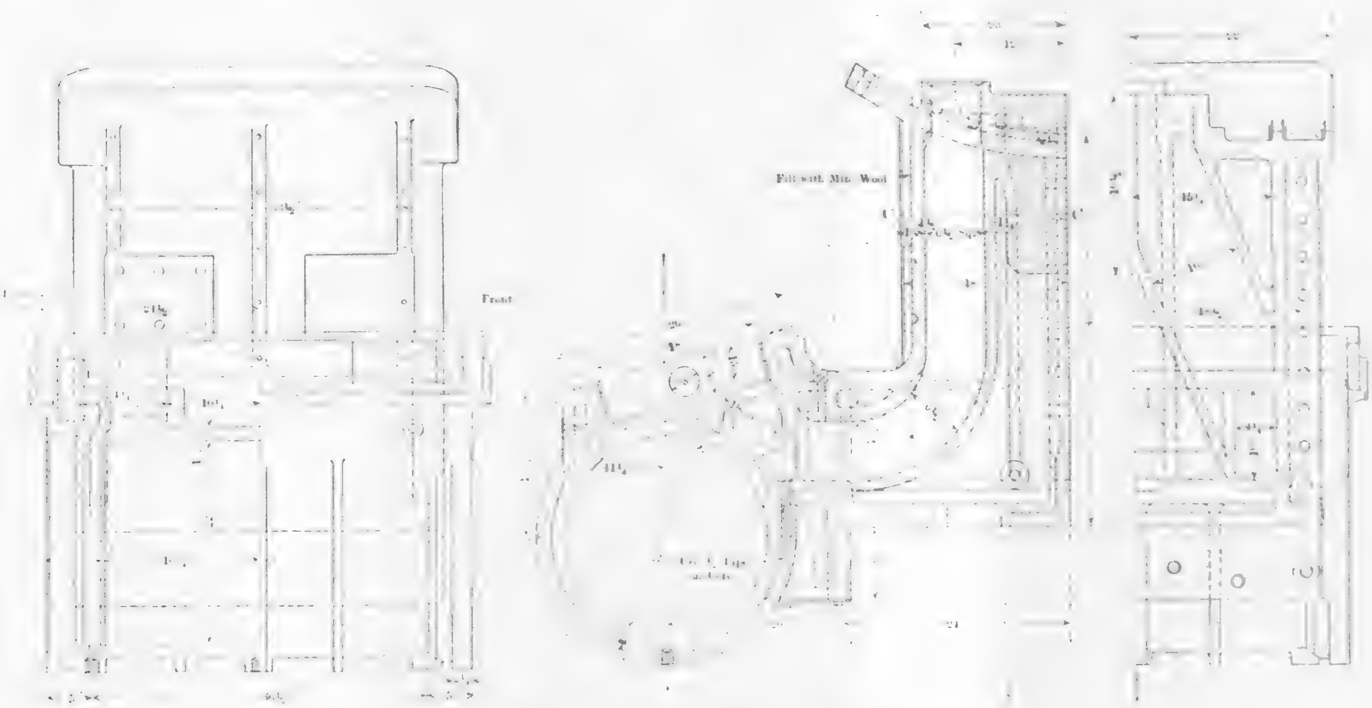


APPLICATION OF ALLFREE-HUBBELL CYLINDERS AND VALVES TO ROCK ISLAND LOCOMOTIVE.

Section C-C.



DETAILS OF ALLFREE-HUBBELL CYLINDER.

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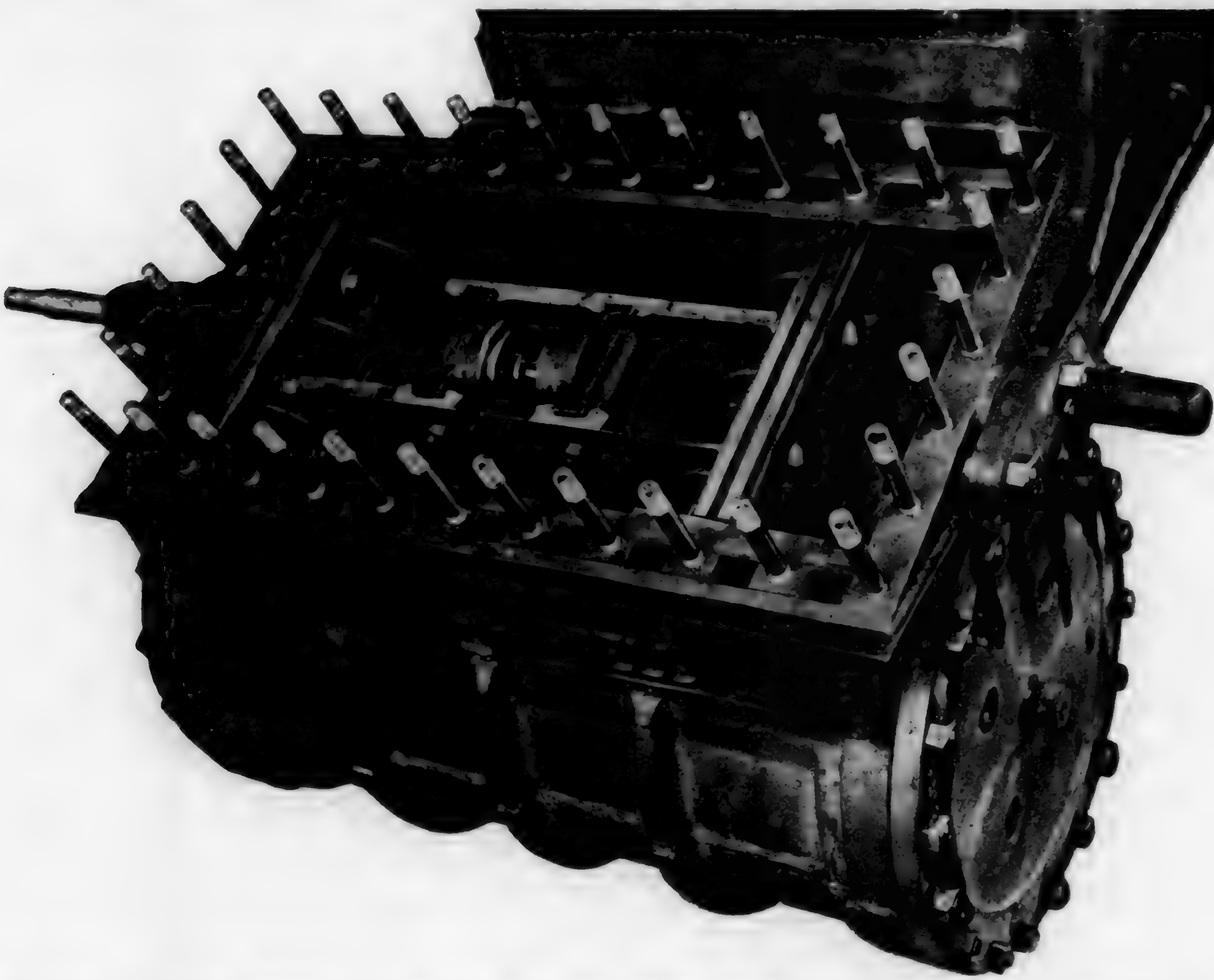
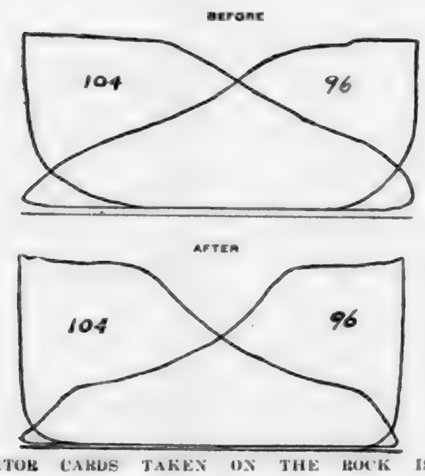
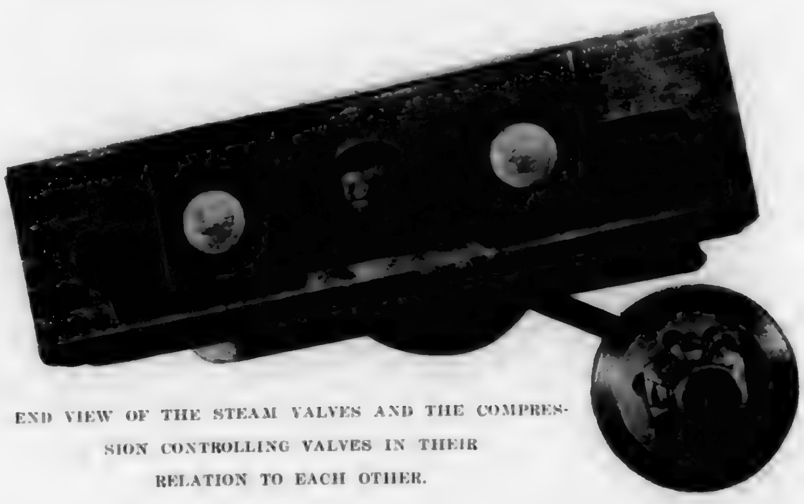


ALLFREE-HUBBELL CYLINDER SHOWING ONE STEAM CHEST COVER REMOVED, EXPOSING THE STEAM VALVE AND VERY CLEARLY SHOWING THE DASH POT CONNECTION TO THE COMPRESSION CONTROLLING VALVES WHICH LIE IN THE BACK SIDES OF THE PORTS.



INDICATOR CARDS TAKEN ON THE ROCK ISLAND LOCOMOTIVE BEFORE AND AFTER BEING EQUIPPED WITH ALLFREE-HUBBELL CYLINDERS.



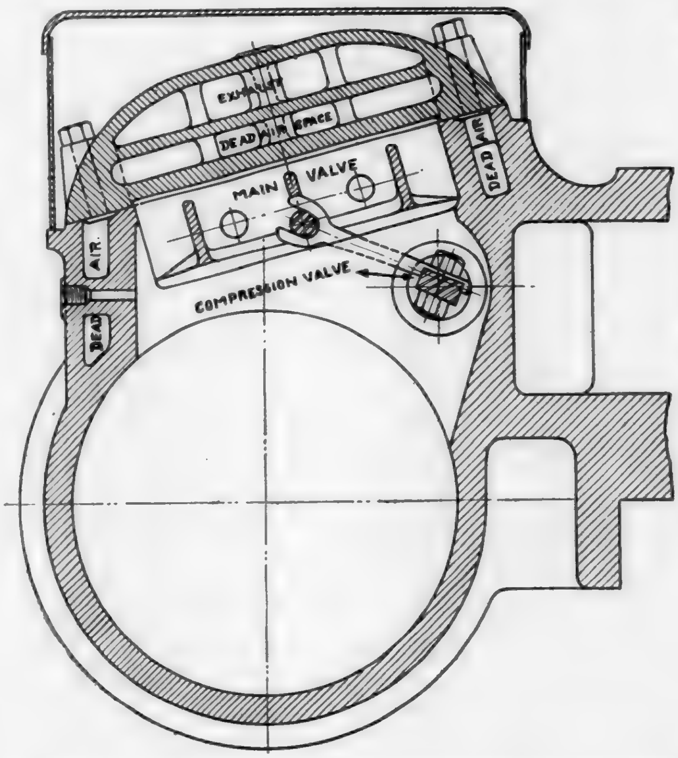
END VIEW OF THE STEAM VALVES AND THE COMPRESSION CONTROLLING VALVES IN THEIR RELATION TO EACH OTHER.

The main steam valves are of a design which is clearly shown in the illustrations and have inside admission. It will be seen that the construction gives a very light weight valve with liberal bearing area and practically perfect balance. The construction is such that even at the shortest cut-off, one portion of the bearing surface of the valve always laps the travel of another portion on the valve seat. Long experience with this type of main steam valve, which is the same as was used on the earlier design of engines, has shown them to be very efficient from a maintenance standpoint. The steam chest cover, which acts as a balance plate for the steam valve, is cored out in such a manner as to leave a dead air space between the exhaust passage and the lower or live steam surface.

An examination of the cylinder design will show that in no case is the live steam passage and the exhaust passage separated by a single wall of metal, thus preventing the loss of considerable heat in the live steam while passing through the cored passages.

As mentioned above, the sides of the pistons, the inside of the cylinder heads and the steam ports are polished. It is a well known fact that a polished surface will absorb much less heat than a rough one, but it is a refinement which has, as far as we know, never before been introduced into locomotive practice.

An examination of the indicator cards taken from locomotives equipped with this design of valve, compared with those obtained from locomotives having the regular piston or balanced slide valves, shows that by virtue of the larger actual exhaust opening, the release can be delayed very appreciably without increasing the back pressure, thus giving a longer expansion line. The delay of final exhaust closure, which is permitted by the large reduction of the clearance space, allows the back pressure line to be carried to very near the end of the stroke and adds considerably to the area of the card. These points will be made clear by reference to the two cards shown herewith, one of which was taken from engine No.



END SECTION OF ALLFREE-HUBBELL CYLINDERS THROUGH THE PORT.

1676 as fitted with piston valves and the other after the application of the Allfree-Hubbell valves. The locomotives Nos. 1676 and 1687 on which the tests were made have the following general dimensions:

SIMPLE CONSOLIDATION LOCOMOTIVE.
CHICAGO, ROCK ISLAND & PACIFIC RY.
GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Freight
Fuel	Bituminous coal
Tractive effort	36,240 lbs.
Weight in working order	206,000 lbs.
Weight on drivers	182,300 lbs.
Weight on leading truck	23,700 lbs.
Wheel base, driving	17 ft.
Wheel base, total	26 ft.
Wheel base, engine and tender	57 ft. 6 ins.
CYLINDERS.	
Kind	Simple
Diameter and stroke	22 x 30 ins.
WHEELS.	
Driving, diameter over tires	63 ins.
Driving journals, main, diameter and length	10 x 12 ins.
Driving journals, others, diameter and length	9 x 12 ins.
Engine truck wheels, diameter	36 ins.
Engine truck, journals	6 x 12 ins.
BOILER.	
Style	W. T.
Working pressure	185 lbs.
Outside diameter of first ring	72⅛ ins.
Firebox, length and width	67¼ x 107 ins.
Tubes, number and outside diameter	387-2 ins.
Tubes, length	15 ft. 6 ins.
Heating surface, tubes	3,087 sq. ft.
Heating surface, firebox	177 sq. ft.
Heating surface, total	3,264 sq. ft.
Grate area	50 sq. ft.

PACIFIC COAST RAILWAY CLUB.—Owing to the destruction of San Francisco and the general unsettled condition of affairs in that region, it has been decided to suspend the business of this club for the present.

COMPARATIVE COST OF REPAIRING STEEL AND WOODEN CARS ON THE HARRIMAN LINES.

Since October, 1904, there has been kept on the Harriman Lines a comparative record by months of the costs for repairing all cars of steel construction and an approximately equal number of wooden cars. The wooden cars chosen are of modern type, built about the same time as the steel cars, and therefore comparable in age, capacity and kind. The figures for the first six months of the record were given in these columns last year (July 21, 1905). Below is the statement for 17 months, which brings the record down to February of the present year. Only the totals for all lines are here given instead of for each of the constituent lines, as in the former statement.

	Steel Cars			Wooden Cars		
	Cars owned.	Total repairs.	Average cost per car.	Cars owned.	Total repairs.	Average cost
October, 1904	11,124	$19,139.45	$1.72	10,701	$35,209.02	$3.29
November, 1904	11,159	19,459.41	1.74	10,701	31,107.18	2.91
December, 1904	11,258	20,828.33	1.85	10,676	33,385.99	3.13
January, 1905	11,258	22,348.76	1.99	10,671	34,308.70	3.22
February, 1905	11,256	26,270.60	2.33	10,660	33,578.92	3.15
March, 1905	11,255	25,290.88	2.25	10,656	36,723.35	3.45
April, 1905	11,254	24,124.18	2.14	10,650	31,024.73	2.91
May, 1905	11,554	28,063.49	2.43	10,652	37,236.75	3.50
June, 1905	11,546	29,183.00	2.53	10,642	37,656.77	3.54
July, 1905	11,546	31,909.79	2.76	10,640	40,201.93	3.78
August, 1905	11,544	31,947.90	2.77	10,634	44,459.61	4.18
September, 1905	11,536	29,609.49	2.57	10,621	42,123.48	3.97
October, 1905	12,536	33,021.66	2.63	10,615	51,556.04	4.86
November, 1905	12,539	31,765.16	2.53	10,604	45,237.82	4.27
December, 1905	12,539	35,898.61	2.86	10,603	48,186.87	4.54
January, 1906	12,536	40,207.78	3.21	10,594	50,355.97	4.75
February, 1906	12,535	33,226.91	2.65	10,583	43,870.22	4.15
Av'ge per month	11,704	$28,370.32	$2.42	10,641	$39,777.84	$3.74

	Steel cars.	Wooden cars.
Box	2,900	6,232
Coal and ore	3,013	152
Flat	2,287	517
Furniture	297	276
Oil	871	248
Stock	2,305	2,699
Ballast and side dump	862	459
Total	12,535	10,583

These cars are classified as follows, based on the February total:

The average total number of steel cars involved was 11,704 against 10,641 for the wooden cars. The average monthly repair costs were $2.42 and $3.74 respectively, a difference of $1.32, or 35 per cent., in favor of the steel cars. The average total monthly difference was $11,407, or $136,884 a year. Referring to the classification, it will be observed that the wooden cars are at a disadvantage in the much greater number of box cars and the relatively small number of coal, ore and flat cars, which cost less to maintain than box cars, especially the flats. And while this causes a greater difference in the figures for average cost per car than would exist if the several classes were on an equality as regards numbers, yet considering totals this advantage is offset, in part at least, by the greater total number of steel cars involved. For February, for example, they were 1,952 in excess of the wooden cars, yet the total cost for repairs to the 12,535 steel cars for this month was $10,000 less than for the 10,583 wooden cars.

One interesting thing to note in both instances is the increase in the average cost per car per month over the period covered by the statement. For the first six months, as given in the previous statement, the respective average figures were $1.98 and $3.19. These increased in the subsequent year to $2.42 and $3.74, or by 22 and 17 per cent. respectively—the effect of an additional year of service. During this time 1,300 steel cars were bought (April-May and September-October, 1905), but no new wooden cars were added.—*The Railroad Gazette.*

RAPID CAR BUILDING.—At the Pullman shops recently an order for 1,500 cars was completed for the New York, Chicago & St. Louis Railway in twelve days, making an average of 125 cars per day.

LOCOMOTIVE REPAIR SCHEDULE.

By C. J. Morrison.

As the locomotive is the money earner of the railroad, the machine which must pay every expense and earn a dividend for the stockholders, and as it is earning only while running, it becomes all important to keep it in motion. This means not only reducing operating delays, but also reducing the time spent in the round house and the back shop. If not very carefully watched an engine is liable to spend a long time in the shop receiving repairs which could be made just as thoroughly in a much shorter time. To prevent this engines must go through the shop on a regular schedule just as a train runs on a regular schedule on the road. It will not do to assign a date when the engine is expected to get out of the shop. A specific time must be set for each operation.

All back shop repairs may be successfully handled on three schedules, namely light, heavy and general. Light repairs to consist of special jobs such as welding a broken frame, patching cylinders, etc. Heavy repairs to consist of turning tires, overhauling machinery, resetting flues, patching firebox, and such other work as may be done without placing the boiler in the boiler shop. General repairs to consist of repairs which require the boiler to be placed in the boiler shop. In one large shop where this classification is used, the number of working days allowed are 7, 14 and 25 respectively. The heavy repair summary schedule is as follows:

ERECTING SHOP. LIGHT REPAIRS.	ERECTING SHOP. HEAVY REPAIRS.		ERECTING SHOP. GENERAL REPAIRS.
Engine stripped. Material delivered. Valve bushings out.	Engine in shop, stripped, valve bushings out.	1	Engine in shop. Off wheels.
Valve bushings in.	Material delivered to the different departments.	2	Stripped. Boiler to boiler shop. Valve bushings out.
Cylinders patched & bored. Cylinder heads machined. Frames welded or straightened.	Valve bushings machined.	3	Material delivered to different departments.
Cylinders bushed. Frames machined. Cylinder heads ground and bolted up.	Cylinders patched, frames welded or straightened.	4	Frames welded or new.
Frames on engine lined and bolted up. Pilot and braces on. Running-board brackets ready and up. Air pump up.	Cylinders bored, frames machined. Valve bushings in. { decks machined. guide yokes forged.	5	Frames straightened.
Cab and boards up. Boiler tested. Cylinders blown out. Steam pipes tested. Engine wheeled.	Guide yoke machined.	6	
Pilot and braces up. Valves set. Rods and jacket on. Out of shop. Pops set.	New cylinders and guide yoke up. decks and frames up. lined and bolted, Cylinder heads machined.	7	Guide yoke forged.
Engine in Service.	Wheels ready.	8	
		9	
	Running-board and cab up.	10	Frames and decks machined.
	Springs on engine.	11	
	Engine wheeled (9 a.m.) Jacket on. Air pump up.	12	
	Valves set. Cylinders blown out. Steam pipe test.	13	Cylinder heads machined. Cylinders patched.
	Pilot and braces on. Rods up. Out of shop, Pops set (12 m.) Break in.	14	Cylinders bored.
	Engine in service.	15	Cylinders bushed. Valve bushings in.
		16	Cylinders (new) up.
		17	Back cylinder heads ground and bolted up.
		18	Boiler to erecting shop. Guide yoke machined.
		19	Frames and decks on engine. Lined and bolted up.
		20	Running-board brackets up. Boiler tested. Guide yoke up.
		21	Cab and running-boards up.
		22	Engine wheeled (9 a.m.) Jacket on.
		23	Valves set. Air pump up.
		24	Pilot and braces on. Rods up. Cylinders blown out. Steam pipes tested. Pistons in.
		25	Engine out of shop. Pops set. (12 m) Break engine in.
		26	Engine in service.

NOTE:
NO DELAYS COUNTED UNLESS ENGINE RUNS INTO ANOTHER DAY ON ACCOUNT OF DIFFERENT DELAYS. MARK TIME GAINED AND TIME LOST, SO THAT THE AVERAGE CAN BE OBTAINED.

WHEN WORK IS AHEAD OF SCHEDULE MARK BY LETTER A.

SIGNS TO BE USED WHEN WORK IS HELD UP.

FIG. 1.—ERECTING FLOOR SCHEDULE FOR LIGHT, HEAVY AND GENERAL REPAIRS.

(The machine work dates are to show when the erecting shop can get the material.)

First Day.—Engine in shop.

Second Day.—All material delivered; engine stripped; valve bushing out.

Third Day.—Valve bushings machined; new cylinders machined; flues out.

Fourth Day.—Frame welded, or new, or straightened; valve rods, yokes and stems, throttle rigging, motion work and grate rigging forged; cylinders patched.

Fifth Day.—Valve bushings in; frames and decks, eccentrics and straps, steam chest work, cylinder bushings, valve rods, yokes and stems machined; piston rods forged; cylinders bored; guides, guide blocks and guide yokes forged.

Sixth Day.—Brake rigging, springs and rigging, and rods forged; driving boxes, tumbling shaft and boxes, steam and dry pipes, throttle valve and rigging and brake cylinder machined; new cylinders up.

Seventh Day.—Cab work and cylinder heads machined; frames and decks placed on engine and bolted up.

Eighth Day.—Rocker boxes, crossheads, brake rigging, guides and blocks, piston rods and heads machined; engine truck work and binders forged; brake cylinders and back cylinder heads up; wheels ready, machine work for link and guide and piston gangs completed; all forge work done; guides and crossheads ready.

Ninth Day.—Grate rigging and binders machined; rocker boxes, tumbling shaft, reach rod, reverse lever and guides up; flue sheets and stay bolts in; flues in; machine work for rod gang completed.

Tenth Day.—Cab and boards on engine and check valves in; throttle valve and throttle rigging up; Dry pipe in engine and boiler tested; boiler work completed; engine truck work machined; shoes and wedges laid off; miscellaneous machine work completed; steam chest work ready; drill press work done.

Eleventh Day.—Springs up; eccentrics and straps on axle; engine truck ready; steam chest work up; lagging on; shoes and wedges planed; floor work before wheeling completed; driving-box work before wheeling; motion work ready; steam pipe bench work done.

Twelfth Day.—Engine wheeled; shoes and wedges and binders on engine; piston ready; jacket on; grate rigging up; nozzle on; steam pipe in; steam pipes tested; air pump up; motion work up; cab fittings ready.

Thirteenth Day.—Cab fittings on engine completed; pistons in engine; valves set; ash pan up; front end and door on engine; rods ready; tanks ready; brake bench work done.

Fourteenth Day.—Rods on engine; pipe work completed; pilot and beam on engine; brake rigging up complete; engine out of shop; pilot braces, coupler, drawbar, etc., up; engine painted; tank painted.

Fifteenth Day.—Engine in service.

This shop is operated by the gang method and each foreman has a card showing when his particular work is to be done. The erecting floor schedule is shown in Fig. 1. These schedules are mounted on heavy cardboard with tin clips at the top and bottom of the second and fourth columns, through which clips, strips of heavy paper with spaces ruled the same as the schedule are run. The slips show the working days for each month. When an engine enters the shop its number is placed on the space for that date. Light and heavy repair engines are placed on the left-hand slip, while general repairs go on the right-hand slip. All that is necessary to ascertain when any job is to be done is to place the engine number on the movable slip against the first day of the schedule, and the date opposite the job in question is the date when it should be completed. At seven o'clock each morning a typewritten notice is handed to each foreman showing how his work stands and a summary is given to the general foreman showing how all the work stands. The general foreman is also given a report showing how many and what class of workmen each gang is short. By comparing the work report with the labor report he is able to assign men from the floating gang to gangs that are liable to fall behind. This method passes engines through the back shop with the regularity of mail train service, and combined with a system of rigid inspection and assignment of work gives the minimum delay with the minimum cost for repairs.

In order to reduce the labor charges it is necessary to know where the money is spent. It is not sufficient to know that one engine cost $1,000 and another $700. It is necessary to know that one gang's work cost $40 on one and $25 on the other, and that each of the other gangs spent so much on one and so much on the other. The superintendent of shops can then tell at once where to go to work to reduce expenses. Each gang is assigned a number. The timekeeper when taking time places this number on the card and the charges are entered up by engines and gangs. The shop is divided up as follows:

Gang.	*Name of Gang.*
1	East Machine Shop.
2	West Machine Shop.
3	East Erecting Floor.
4	West Erecting Floor.
5	Tank Truck.
6	Air Brake.
7	Valve.
9	Pipe.
10	Tool Room.
11	Steam Pipe.
12	Driving Box.
13	Drill Press.
14	Spring and Brake.
15	Grate.
16	Steam Chest Gang.
17	Brass Room.
18	Link.
20	Stripping.
21	Guide and Piston.
22	Rod.
23	Engine Truck.
24	Cab Fittings.
25	Yard Laborers.
29	Drilling Gang.
30	Boiler.
30-1	Boiler Shop—Flue.
30-2	Boiler Erecting Floor.
30-3	Ash Pan.
30-4	Steel Cab Gang.
31	Tank Boiler Work.
35	Sweepers.
40	Forge.
41	Tin Shop.
43	Wheel and Axle Shop.
47	Electricians.
52	Locomotive Carpenters.
56	Upholstering.
70	Paint.

No "Floating Gang" appears as the members of that gang are always distributed among the other gangs.

As soon as an engine leaves the shop its account is closed. In about five or six days a card, showing the cost of the work of each department, both labor and material, on the engine is placed in the hands of the superintendent of shops. He compares it with the work report, and if there is a discrepancy in any department the foreman is called to account.

A rigid inspection of each engine is made and an estimate prepared of the cost of work for each department. The portion of the work for each department is handed to the foreman of that department, as soon as the engine is stripped. A sample report for the driving box gang is as follows:

WORK TO BE DONE ON ENGINE 1,000 (HEAVY REPAIRS).

Driving Box Gang..................................No. 12

Plane the driving boxes; lay off shoes and wedges for lining and planing; rivet in liners; all brasses and lateral are in good condition; put the boxes on the journals; pack the cellars and tops of boxes; see that the spring saddles enter boxes when engine is being wheeled; put up the shoes, wedges and binders; see that the wheel centers are put to tram; engine will need new frame pedestal ties as per blue print 6/441.

He is to do no other work without permission of the inspector or the superintendent of shops. This prevents much unnecessary work and makes one man responsible for the repairs to the engine. Such foremen as are inclined to build a locomotive like a watch are restrained, while others who are liable to slight their work are spruced up. The system also prevents wasting material, as no material can be scrapped, or new material ordered without the O. K. of the inspector.

This system has not only made a considerable saving in the time for repairing engines, but has also reduced the cost of repairs an astonishing amount. At the same time the engine failures on the road have shown a steady decrease. The method, with proper modifications, can be applied to any shop.

THE COMPOUND LOCOMOTIVE.—It may seem strange, in view of the superior economy of compound locomotives, that they have not been adopted generally in place of single expansion locomotives. Compounds are apparently increasing in favor at the present time, and this is to be explained rather on the ground of the increased capacity which they render available rather than because of their superior economy. It is claimed by those who have used compounds and discarded them that the additional cost of maintenance, because of the somewhat increased complication, more than offsets the advantage gained by saving a little fuel. While this may have been true some years ago, it is not believed to apply to the more recent types of compounds, and it may even be claimed at the present time that the feature of economy may be disregarded. This is because of the very much more important attribute of the compound in applying increased capacity. At the present time railroad men are so anxious to secure the utmost possible capacity that they are willing to accept some additional trouble and expense in maintenance in order to secure the additional power which every railroad now requires in order to deal with trains of increasing weights and speeds. Reliability of service in summer and winter is now becoming very important in competitive passenger service. For this reserve capacity is necessary.

When a railroad official faces the increasing weight of trains and increasing severity of schedules he is ready to grasp at anything which will help him out of the difficulty. Because compounds do increase capacity, young men who are now preparing to enter motive power service will find it advantageous to have well defined opinions as to the possibilities of the compound to meet future requirements, which are going to be more difficult than those of the past or present. When the question of locomotive design is raised on a railroad where an additional car must be hauled and the time must be somewhat shortened, the compound locomotive lies ready at hand to meet this need. Those who are most competent to judge believe that the locomotive of the future is sure to be a compound.—*Mr. G. M. Basford, at Purdue University.*

STEEL MOTOR CAR—LONG ISLAND RAILROAD.

ELECTRIFICATION OF THE LONG ISLAND RAILROAD.

PASSENGER CAR EQUIPMENT.

The design of the car equipment of the Long Island Railroad is based upon a careful study of the traffic conditions, as they were outlined at the commencement of the undertaking, calling for trains with the number of cars varying from 2 to 6 per train at different hours of the day in regular operation and occasional trains of from 10 to 12 cars for heavy excursion travel. Some of the service is express and some local, and it was deemed of the greatest importance to provide a single type of equipment that would be uniformly available for all the varying conditions of train service.

The schedule originally planned called for speeds, including stops, of about 25 miles per hour for local trains and 30½ miles for express trains on the Atlantic Division. The service on other divisions would not exceed these speeds. A careful study of the conditions led to a decision to use the multiple-unit system for the trains, which would be composed of varying numbers of motor and trailer cars depending on the speed required. This decision, and also the fact that the Atlantic Division is partially in a subway, as well as the future need of interchangeability of equipment with the Interborough Rapid Transit Company when the tunnel from the South Ferry Station of that company underneath the East River to the Flatbush Avenue Station of the Long Island Railroad is completed, which will make posible the running of through trains from the New York subway over the Long Island Railroad, has much to do with the design of the cars.

The complete success of the all-steel passenger cars in use on the Interborough subway, which were designed by Mr. George Gibbs, led him in his capacity as chief engineer of the Long Island Railroad Electric Conversion to advocate the use of practically identical cars on this road.. These cars represent the highest development of safety for passenger traffic, as they are practically fireproof and of superior strength and durability. Thus the design of passenger car finally adopted is a practical duplication of the all-steel cars of the Interborough Rapid Transit Company. These cars were very thoroughly and completely illustrated in this journal in October, 1904, page 395, to which reference can be made for many of the details which will not be duplicated in this article.

The motor and trailer cars are practically the same with the exception of the truck, and trailer cars can readily be converted into motor cars, whenever desired, by the substitution of motor trucks.

The car bodies have the following general dimensions:

Length over draw-bars	51 ft. 4 ins.
Length over body corner posts	41 ft. ½ in.
Width over eaves	8 ft. 8 ins.
Width over sheathing	8 ft. 7 ins.
Width over window sills	9 ft. ½ in.
Height from top of rail to top of roof	21 ft. ¾ in.
Height from underside of center sills to top of roof	8 ft. 9¼ ins.

While the conformation of the car body is practically identical with the usual type of steam railroad coaches, the adoption of steel as a constructive material is responsible for some differences in the general design of the steel frame, but most of the standard parts in the framing of wooden cars have their counterparts in the framing of steel cars, as will be seen in the following general description of the car framing.

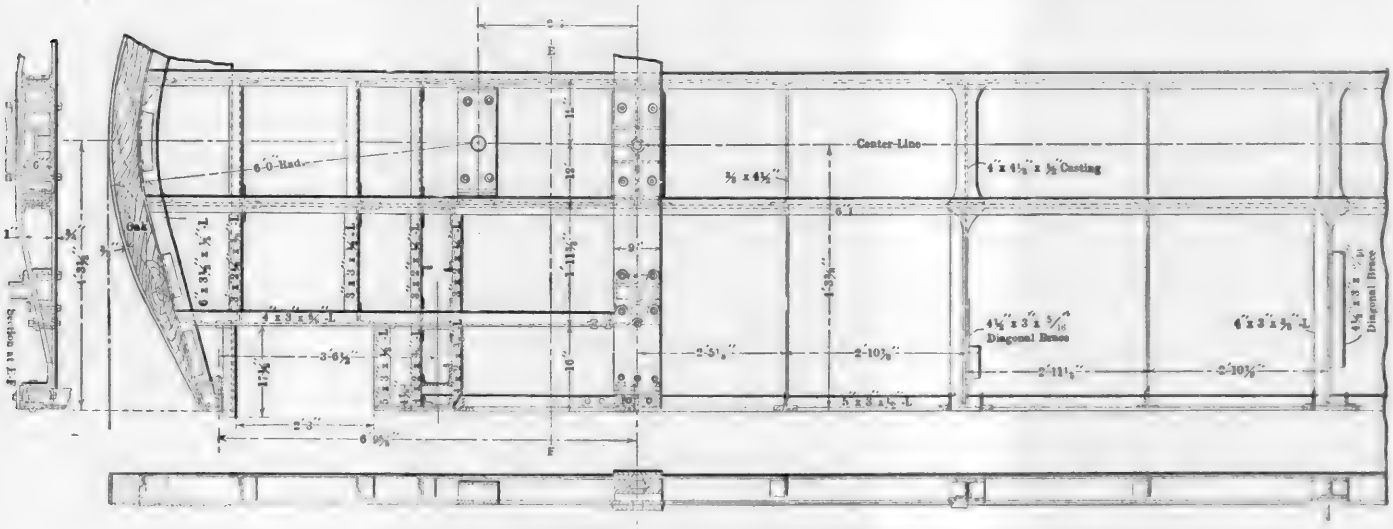
The most noticeable difference in design compared with the usual passenger coach is the method of carrying the load, which in the steel cars is all transferred to and carried by steel trusses, which form the sides of the car below the belt rail. These trusses are made up of a bulb section belt rail, the angle iron side sills, the angle, tee and channel members of the side posts and the ⅛-in. steel plate side sheathing of the car, all of which are securely riveted together and form the truss of square panels of sufficient strength to carry the full load of the car without appreciable sagging. Two 6-in. I beams, which are continuous between the platform end sills form the center sills of the car and take up the pulling and buffing stresses. These in addition to the 5 by 3 by ½-in. angles, forming the side sills, just mentioned as the bottom members of the side truss, which extend for the full length of the car body and as far as the gangway for the steps on the platform, form the only longitudinal parts of the floor outside of the 4 by 3 by ⅜-in. angles extending from the platform end sill to the bolster, making up for the discontinuance of the side sills at the step gangway.

The weight of the floor and the load is transferred to the side trusses by means of four sets of diagonal braces which reach down from the side posts of the car below the belt rail and are fastened to the floor framing, as shown in the cross section of the car. These diagonal braces are concealed in the backs of the stationary cross seats so that their presence in the car is not evident after the seats are installed. The floor framing at the point where these diagonal braces con-

nect consists of a 4x3x⅜-in. angle extending across between the center and side sills, being fastened to the T iron forming the center of the double side post at this point and by an angle connection to the web of the center sill. Between the center sills is an I section casting and passing below the sills at this point is a 3 by 3 by ⅜-in angle, which is formed with a proper shape and extends only as far as the lower end of the diagonal brace. Shorter diagonal braces located midway between the ones just mentioned and the bolster do not have the angle iron passing below the center sills, but are connected directly to the

The bolsters are of the built-up type, made up of two rolled steel plates passing above and below the center sills and machined at their outer ends to fit perfectly together. They are bent down to pass below the side sills and are fastened securely thereto in the manner shown in the illustration of the floor framing. A steel casting fits between the center sills at the body bolster. The platform is stiffened by several angle irons between the different longitudinal parts, whose location and size is shown in the floor framing.

The side posts of the car, of which there are 16 on either

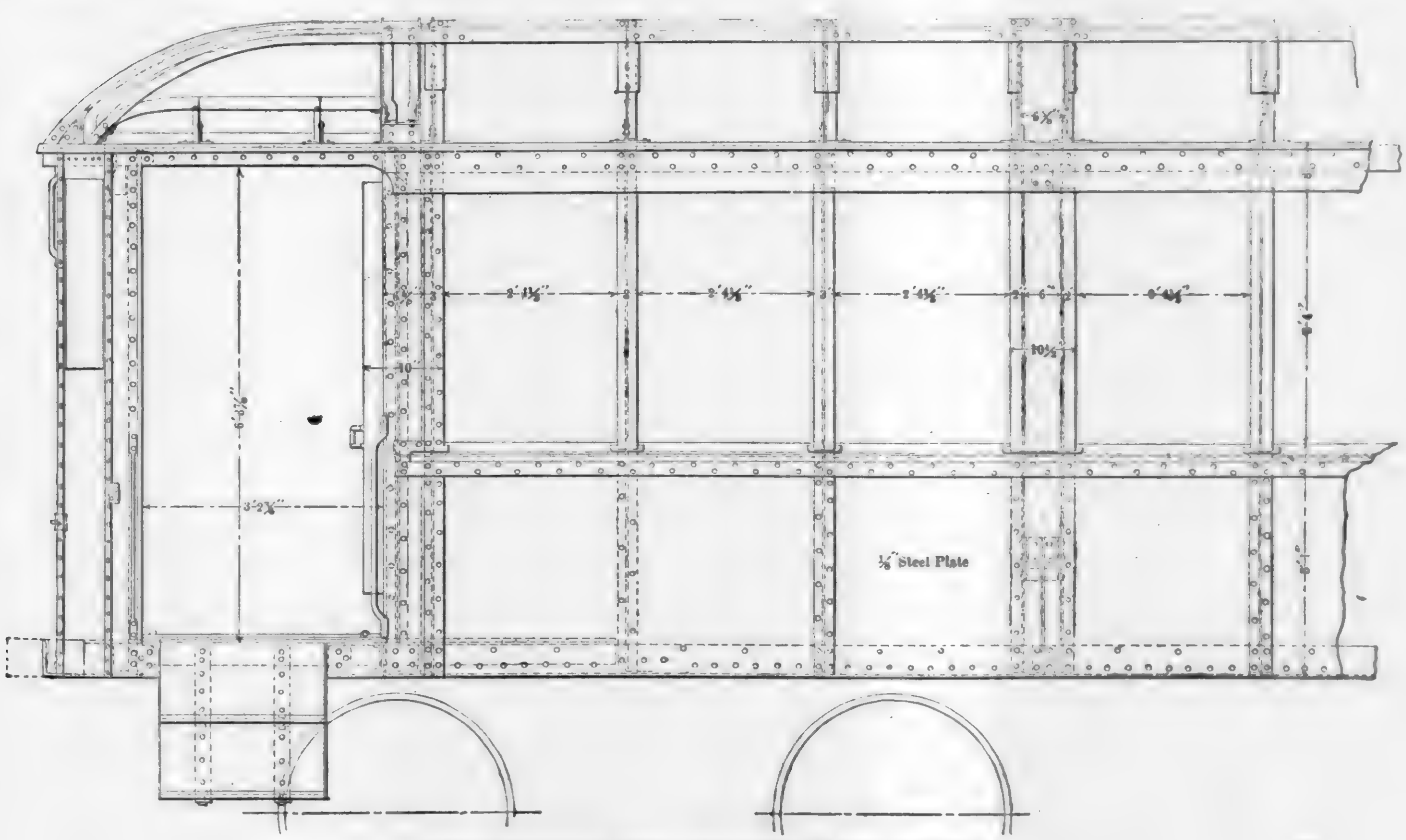


PLAN OF UNDERFRAME—LONG ISLAND STEEL CAR.

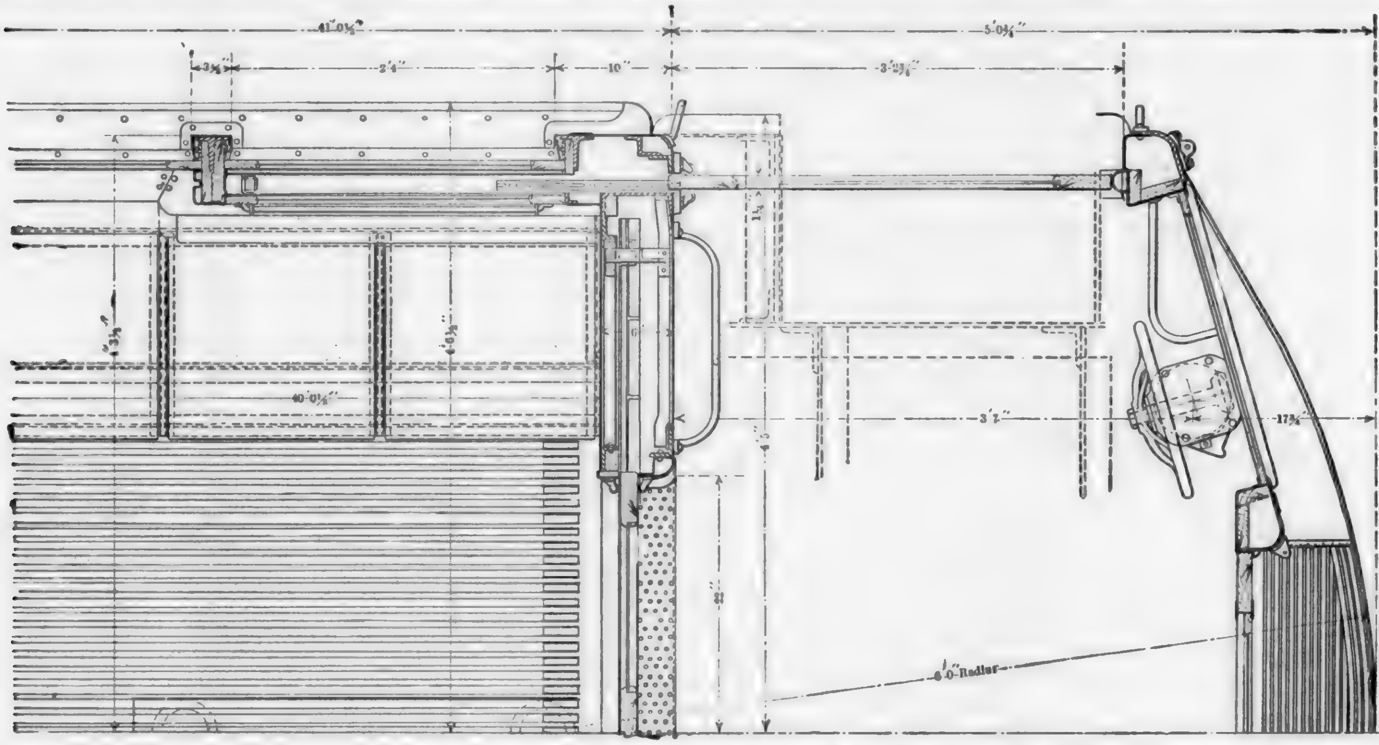
angle between the side and center sills. Between each of these diagonal braces the floor framing is further stiffened by ⅜ by 4½-in. vertical plates between sills.

The platform sills are heavy angles bent to give the proper shape and are continuous from side to side. The vestibule end posts are fastened to them with heavy steel castings. The end sills of the car body are not made as a continuous piece extending completely across the car, but in the form of a double set of short angle bars fastened between the side and end sills by angle iron braces.

side, six being compound or double, and ten single, the former being made up of two 3 by 2 by ¼-in. angles spaced six inches apart. Between each is placed a 6 in. channel with its face turned outward and flush with the outer edge of the angle irons. In the center of this channel is fastened a 3 by 3 by ¼-in. tee, the whole being securely riveted together and forming a very stiff and substantial construction. The single side post is but 10 inches back and really forms part of the con- which are separate from the side posts, although the first side post is but 10 inches back and really forms part of the con-



SIDE FRAMING OF STEEL CAR—LONG ISLAND RAILROAD.



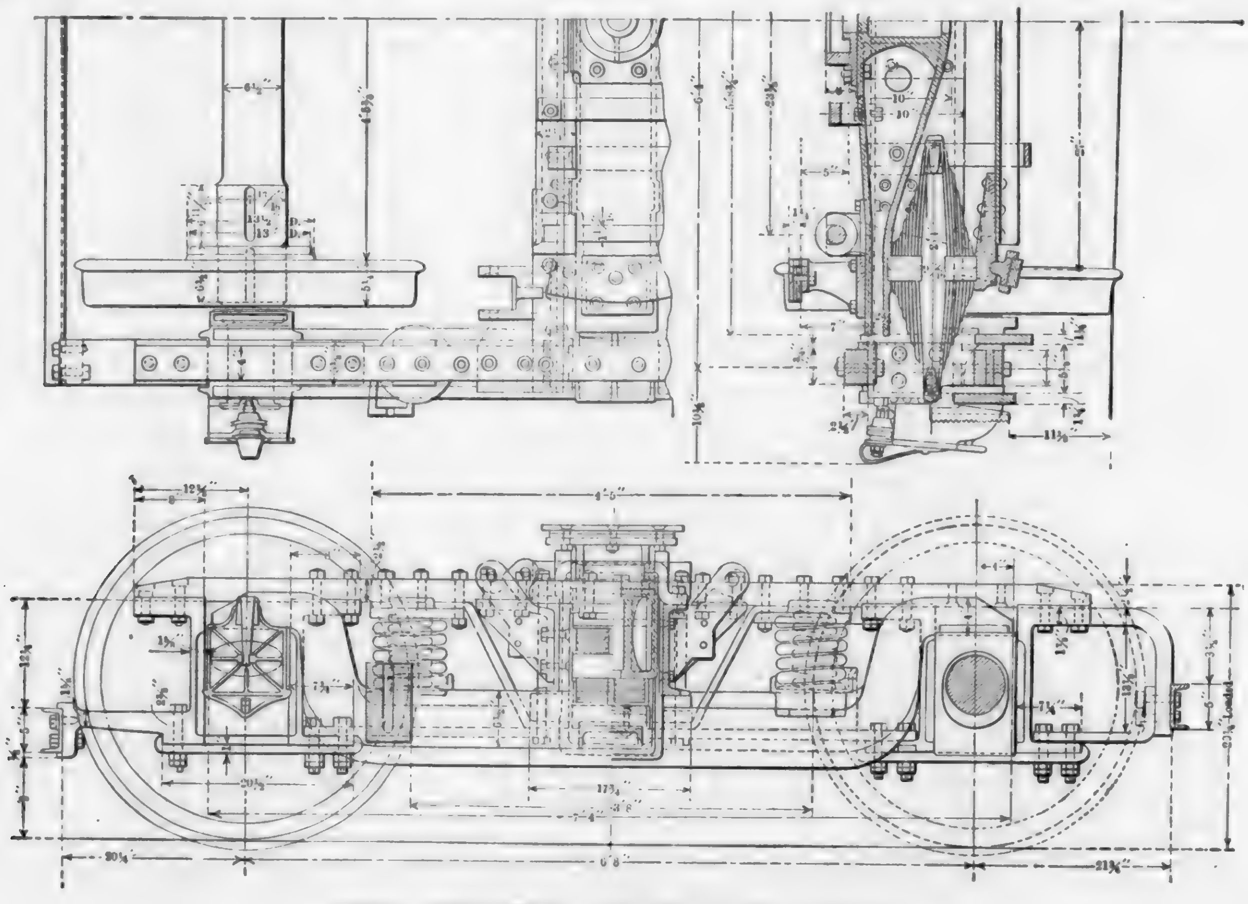
SECTION AT THE END, SHOWING ARRANGEMENT OF SLIDING DOORS.

struction of the corner posts, is built up of an angle bar fastened to the side sill and to the end plate and reinforced by a Z bar. The sheathing is rounded at the corner and riveted to this post and the first side post, forming what amounts to practically an end post 3 ins. thick by 10 ins. long. The pocket for the sliding door of the vestibule, as well as for the sliding door of the car body, requires some special construction at this point, which is shown in one of the illustrations.

The side plates, which are secured to the top of the side posts, are made up of 4½ by 3 in. angles, which are not broken at the vestibule side doors, but are continued in one piece from end to end of the car vestibule hoods.

The end plates of the car body framing are of heavy angles and are in duplicate on account of the door pocket construction. They are framed directly across at about 4 inches above the level of the side plates to which they are connected by a pair of braces of heavy angles, forming a sort of Z bar connection.

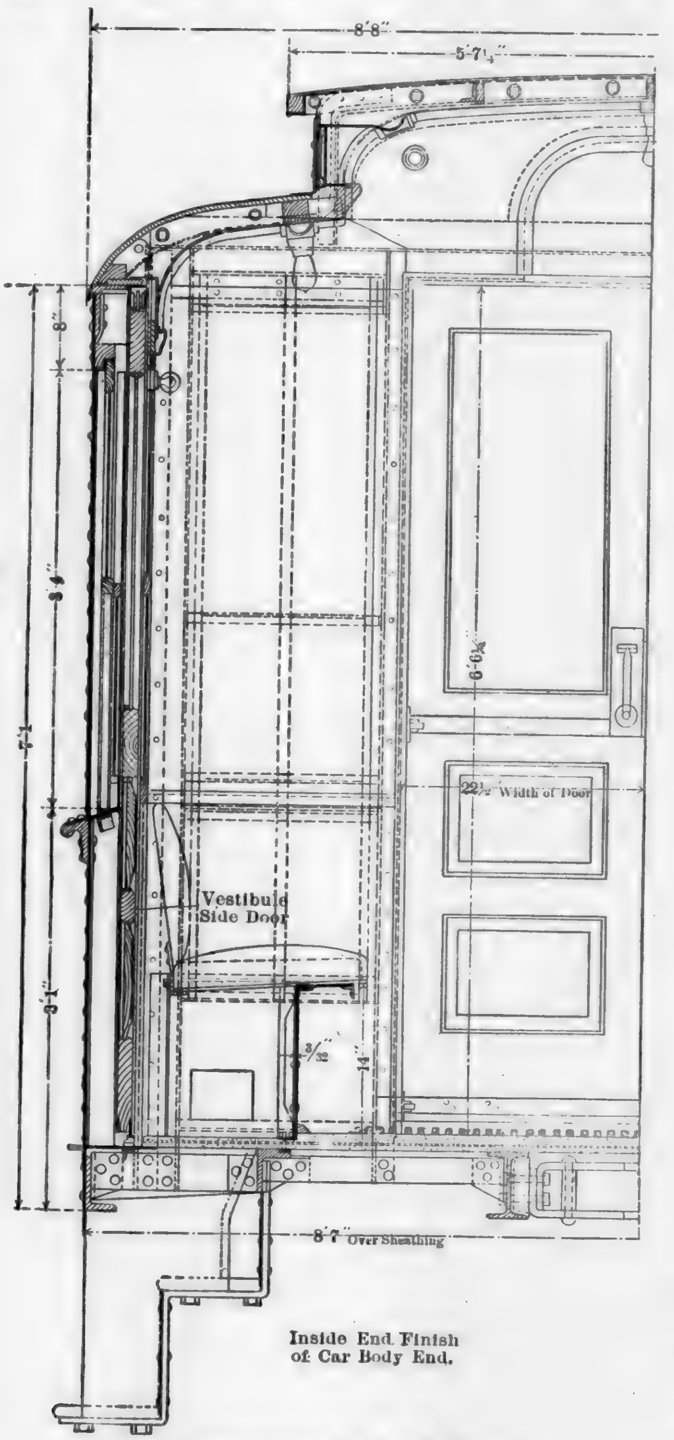
The roof framing consists of bent steel angles forming carlines connected by purlines of light steel angles. The carlines are fastened to malleable iron castings, which are riveted



MOTOR TRUCK—STEEL CAR—LONG ISLAND RAILROAD.

to the side plates. The roof of the vestibule is supported by arched angle bars which are riveted to the end bows and end carlines. A light roof covering is used consisting of composite board ⅜ of an in. thick, except over the vestibule where it is sheet steel, the whole being covered with a heavy canvas laid on with white lead.

The side sheathing consists of ⅛ in. steel plates, the lower edges being flush with the bottom of the side sill. The bulb

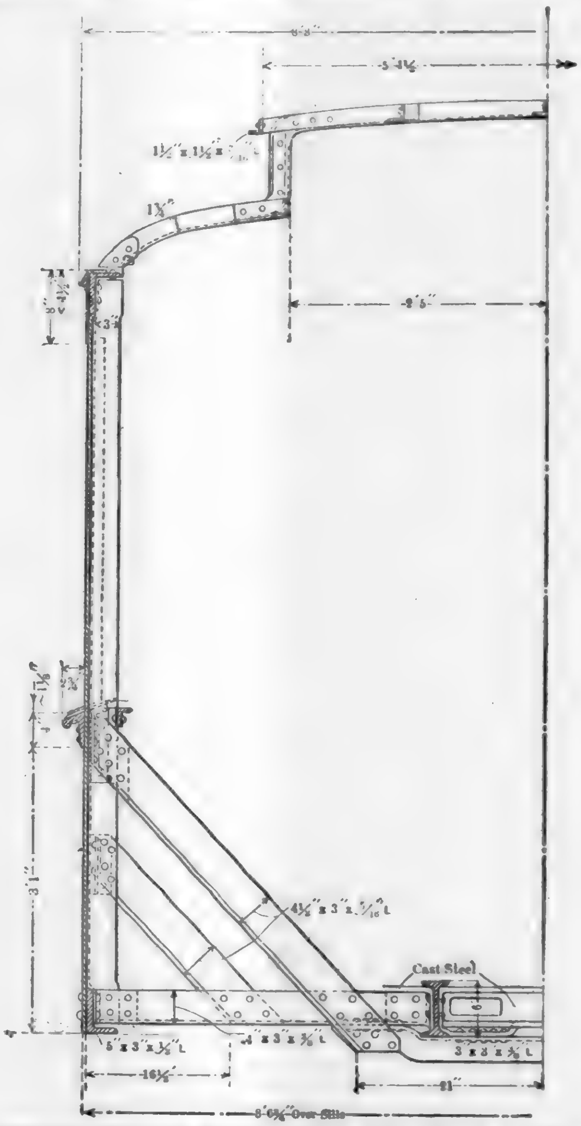


HALF CROSS-SECTION NEAR END OF CAR.

angles which form the belt rail and the window sill overlap this sheathing. The post covers between the windows are of special pressed steel flanged out at their lower ends to fit over the belt rail. The top ends of the post covers extend under the letterboard, which is a steel plate 7 1-16 ins. wide, running the entire length of the car, riveted to the side plates. All joints between the side sheathing plates are covered with steel battens laid on with thick red lead and secured by rivets.

The flooring is of corrugated iron and is supported by the longitudinal sills and the steel plate bridging riveted between the sills. These corrugated sheets are provided with metal clips which secure the "Monolith" plastic floor upon which after being finished the maple floor strips are laid and fastened with brass screws. This "monolithic" floor is absolutely fireproof and is laid in the form of cement, which when set has a smooth hard finish. The interior of the car is finished as follows: The window panels, end panels, and moulding inside of the car are of sheet steel painted a dark green striped with gold. The linings are of composite board and the hardware fittings are of lacquered bronze. The seat frames are of steel construction carried upon brackets riveted to the side posts. The cushions and seat backs are of rattan. The seating capacity of each car is 52 persons. The wainscoting is of steel backed by asbestos.

Considerable wood is used as backing and for fastening the



CROSS-SECTION SHOWING FRAMING NEAR THE MIDDLE OF THE CAR.

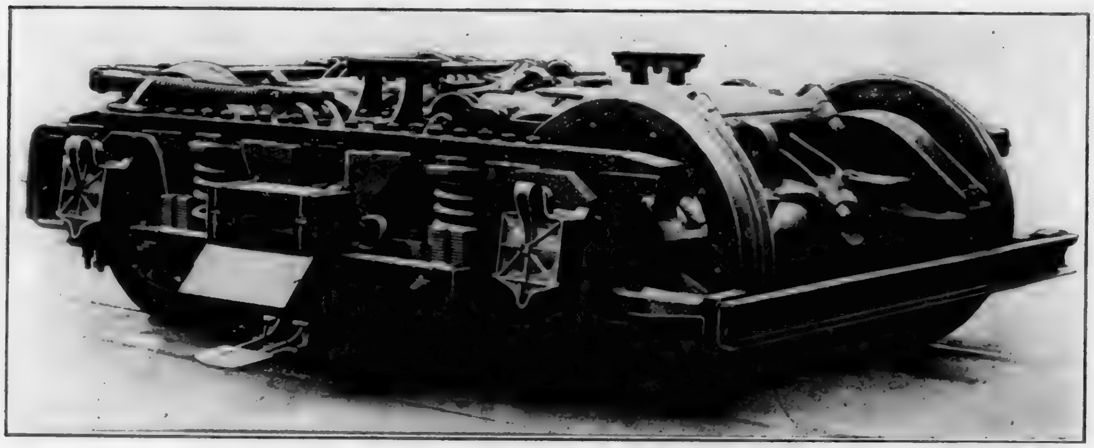
interior fittings to the steel frame work, and this in all cases is thoroughly fireproofed. It is fitted and fastened to the different steel parts by bolts and rivets in the manner shown in the different illustrations.

The draft gear comprises a spring draw bar supported by a sector bar under the car platform. The radius bar is centered upon a pin set in the cast steel auxiliary bolster bolted to the centre sills about 2 ft. 7 ins. ahead of the body bolster. Reaching back from this point to the body bolster, where it is fastened in a similar manner, is a continuation of the radius bar. On each side of the draw bar safety coupling chains are provided fitted with springs and anchor forgings.

The vestibules are the Gibbs patent type with floors of steel plate. The side doors slide into pockets in the side of the car and close against pneumatic cushions, so as to readily release the clothing of passengers if caught in the doors. The device for operating these consists of a series of bell cranks and

levers, so arranged that the movable parts are either overhead in the vestibule or entirely outside of it. The gangways leading to the side steps are fitted with drop doors of 3-16 in. steel plates. The vestibule floor and drop doors are covered with the Mason patent floor covering. The vestibule end door when in the extreme open position is folded over the master controller, brake valve and other apparatus in the motorman's compartment. When it is closed the entire vestibule is available for the motorman.

All motor cars are equipped with pilots suspended from the platform buffers, and an air whistle is provided over each vestibule,



MOTOR TRUCK—LONG ISLAND STEEL CAR.

TRUCKS.

The motor and trailer trucks, there being one of each under each motor car, are of the M. C. B. type, the wheel base of the motor trucks being 6 ft. 8 ins. for 36-in. wheels, and of the trailer trucks 5 ft. 6 ins. for 30-in. wheels. The distance between truck centers is 34 ft. The motor truck bolsters and center plates are steel castings machined where necessary. The side frames are of rolled iron machined on all sides. The end frames are steel channels. The pedestals are forgings lipped over the side of the side frames and machined where they have a bearing. The transom consists of a rolled steel channel resting in a casting, forming part of the side frame and provided with chafing plates of wrought iron. The pedestal caps are of wrought iron machined and carefully fitted to the pedestals. The wheels are steel tired with cast steel spoke centres The journal boxes are of cast steel and were furnished by the T. H. Symington Company of Baltimore.

The trailer trucks differ from the motor trucks largely in the matter of size, having, however, a built up bolster of wood and iron plates. Both the motor and trailer trucks were manufactured by the Baldwin Locomotive Works, Philadelphia, Pa.

TRAILER TRUCK—LONG ISLAND STEEL CAR.

The cars are equipped with hand brakes and with the Westinghouse quick service automatic air brake. This brake is of a new design developed from the quick action brake. Air is furnished by electrically driven compressors on each motor car, which have a capacity of 24 cu. ft. of free air per minute. This type of brake has a number of advantages over the standard apparatus, in that it has a quicker serial service application, a more graduated release of cylinder pressure, quicker charging of auxiliary reservoirs and better protection against over pressure. The modifications made in the quick action brake to obtain these advantages, allow the brake to be applied more rapidly and materially reduce the distance required to stop the train. The advantage of the quick charging of the auxiliary reservoir is particularly valuable in the rapid transit service where frequent stops are necessary. All motor and trailer cars are provided with automatic slack adjusters.

ELECTRICAL EQUIPMENT.

The selection of the electrical equipment of the motor cars, whether operated singly or in trains, required a most careful study of the loads to be handled, the schedule conditions and the limitations of the apparatus itself. A careful investigation showed that the greatest flexibility would result from a two motor car equipment, using the most powerful motors practicable. The limitation in the size of the motors was mainly that of the space allowable in the truck, and this restricted the size of the motor to about 200 h.p. Two motors of this size, which are known as No. 113 Westinghouse type, are mounted on the motor trucks and drive the axles through gearing, the pinion on the armature shaft having 25 teeth and the gear on the axle 56 teeth. The motors are supported by a bearing on the axle and by a spring nose suspension from the truck frame.

The Westinghouse electro-pneumatic multiple control system, which was adopted, uses air pressure for operating the switches which control the motor speeds and connections, which air pressure is controlled by valves operated by electric magnets. These magnetic valves are electrically operated from the master controller. The current for operating the air valves is obtained from an independent storage battery of seven cells carried on each motor car. This storage battery is automatically charged from the same circuit that operates the air pump. The air pressure is obtained from the auxiliary reservoirs.

Special precaution was taken to place automatic safe guards at every possible point in the electrical equipment. It is so arranged that too much current or none at all will automatically bring the control apparatus to the off position, and a very slight movement of the master controller handle from this position back to the centre of the notch applies the brake instantly.

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INTERIOR OF INSPECTION SHED AT DUNTON—LONG ISLAND RAILROAD.

panel type placed underneath the seats, and were supplied by the Consolidated Car Heating Company for the motor cars, and by the Gold Car Heating & Lighting Company for the wooden trailers.

The following table gives the weights of the principal elements of the steel motor and its equipment:

	Pounds.
Body	31,377
Draw-bars	988
Foundation air brakes	1,165.5
Brake pipes and fittings	520
Brake schedule parts (including compressor)	2,383.5
Door operating device	340
Supports for electrical apparatus	438
Curtains	99
Seats	844
Motor truck, with gears and third rail shoes	14,129
Two Westinghouse No. 113 motors	14,430
Trailer truck with third rail shoes	9,719
Electrical apparatus and conduit	4,857
Lights, heaters, flexible conduit and wire mouldings	848
	82,138
Maximum passenger load, estimated	16,000
Total	98,138

In addition to the passenger car equipment five electric express cars have been provided, which are equipped with the standard type of motor and trailer trucks and the standard multiple control apparatus. These cars are built of wood, 52 ft. 5 ins. over all. They are equipped with standard M. C. B. couplers, and haul the old standard baggage and express cars as trailers. A rotary snow plow has also been provided, built by the Peckham Manufacturing Company, equipped with one motor and one trailer truck of the standard type, as well as all of the standard motor car electrical equipment. A set of revolving blades with fan and housing is mounted at each end of the car and is operated by a line shaft running through the car and fitted with two friction clutches, one for each end section; the centre section carries two 50 h.p. railway type motors run by a series parallel controller.

Car Shops.

The facilities provided for inspection and repair of electric motor cars consists partially of a section of the original car shop at Morris Park, which has to a certain extent been remodeled to better accommodate the new motive power, and also of two inspection pits, one at Rockaway Park and the other at Dunton. The interior of the latter is shown in the illustration.

At Morris Park a new shop was built paralleling the old car shop with a transfer table situated between them. There are 13 pit tracks, each of which will accommodate two motor cars with plenty of space between them. Two tracks in this shop are provided with traveling cranes for handling motors and axles, and to facilitate general truck repairs. The original machine shop was equipped with new tools for turning wheels and axles, and for pressing wheels and gears upon the axles.

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The entire work of design and construction was in charge of Mr. Geo. Gibbs, chief engineer of electric traction of the Long Island Railroad.

To Make Vandyke Prints More Transparent.—To a pint of best gasoline, add as much paraffine as the gasoline will readily dissolve and spread this solution evenly over the print with a soft brush, wipe dry with a piece of white cotton rag and print in the usual manner. Vandyke prints treated in this way will require only about two-thirds the usual time to print.—*Mr. E. W. Bowen in Machinery.*

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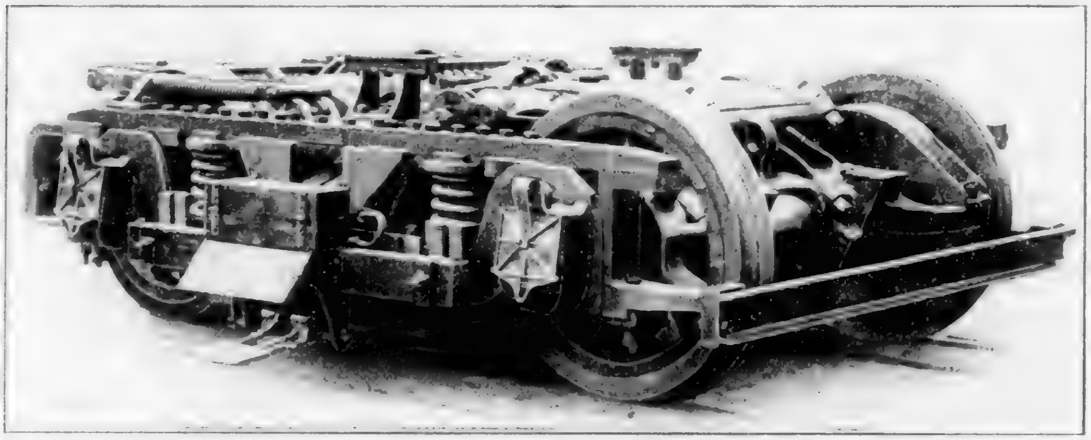

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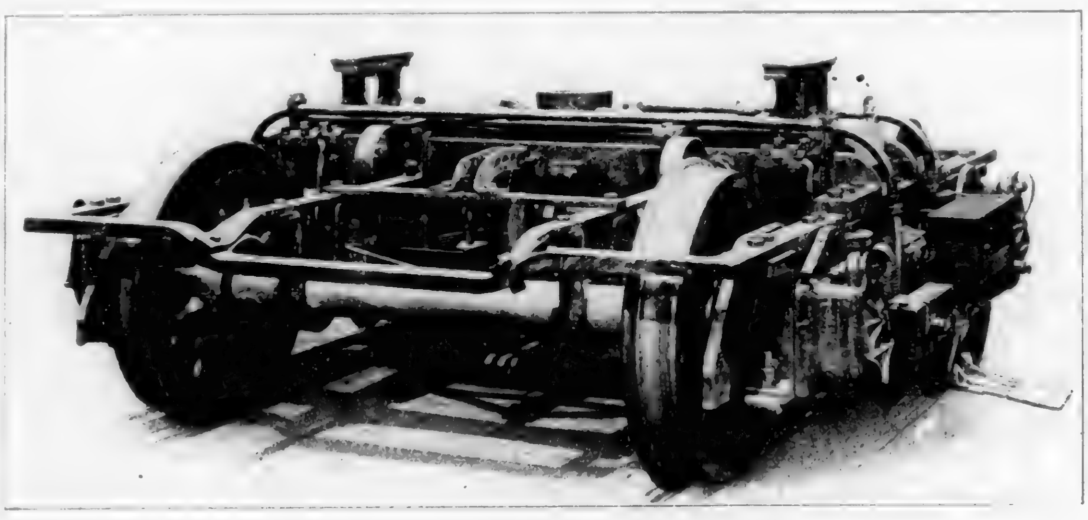

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HEAVIEST 0—6—0 TYPE SWITCHING LOCOMOTIVE—PITTSBURGH & LAKE ERIE RAILROAD.

HEAVY SIX-WHEEL SWITCHING LOCOMOTIVE.

PITTSBURGH & LAKE ERIE RAILROAD.

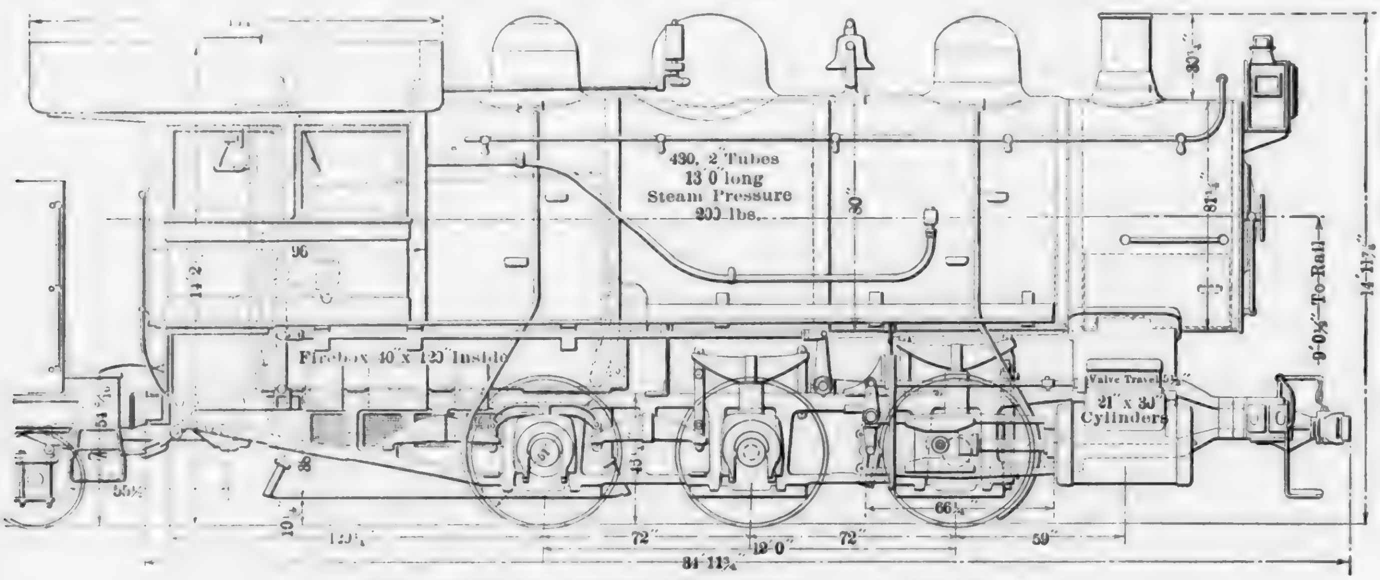
The Pittsburgh & Lake Erie Railroad recently had a number of very heavy six-wheel switching locomotives built at the Pittsburgh works of the American Locomotive Company. These engines were designed to push heavy trains up the "hump" in the gravity yards. As the total weight is equal to the weight on drivers of the most powerful consolidation locomotive in use on this road, and as the tractive effort of 44,100 lbs. is also equal to that of the consolidation locomotive, it is possible for them to handle any train which is hauled into the yards.

The total weight is 176,500 lbs. and the average load per wheel is 29,416 lbs. This, we believe, is the heaviest locomotive of this type ever built in this country, or in the world, and the load per wheel is greater than that of any other locomotive in our records. The heaviest engine of this type, previously built, was the Class B6 constructed by the Pennsylvania Railroad in their Altoona shops in 1904, and described on page 384 of the AMERICAN ENGINEER for that year. These weighed 170,000 lbs., with an average weight of 28,333 lbs. per wheel. These two engines are in a class by themselves among six-wheel switchers, exceeding all others by from 15,000 to 20,000 lbs. in weight.

The reason for placing this excessive weight on three pairs of wheels rather than distributing it over more drivers in an 0-8-0 or 0-10-0 type was to keep the rigid wheel base as short as possible, the wheel base being 12 ft. The P. & L. E. officials believe that a switcher with this wheel-base will work better over frogs and switches, and with greater safety from derailment than one with a larger wheel base. Mr. L. H. Turner, superintendent of motive power, advises that these engines are used in three different yards, and that their performance has been entirely satisfactory. They have been in service over two months.

Just what effect the excessive weight will have on the rate of wear of the rail is a question. Even though the rate of wear should rapidly increase it will probably prove a small item as compared to the fact that these engines will do the work of two six-wheel switchers of ordinary size, thus greatly facilitating the work in the classification yards and simplifying the problem of taking care of the constantly growing traffic.

To keep the bearing pressure within reasonable limits, the journals are unusually large, 10½ by 13 ins. The ratio of the heating surface to the cylinder volume is somewhat higher than the average. Following are the leading dimensions and data:



SIX-WHEEL SWITCHING LOCOMOTIVE—PITTSBURGH & LAKE ERIE RAILROAD.

SIX WHEEL SWITCHING LOCOMOTIVE.
PITTSBURG & LAKE ERIE R. R.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Switching
Fuel	Bituminous coal
Tractive power	44,100 lbs.
Weight in working order	176,500 lbs.
Weight on drivers	176,500 lbs.
Weight of engine and tender in working order	305,500 lbs.
Wheel base, driving	12 ft.
Wheel base, total	12 ft.
Wheel base, engine and tender	46 ft. 2¼ ins.

RATIOS.

Weight on drivers ÷ tractive effort	4
Total weight ÷ tractive effort	4
Tractive effort x diam. drivers ÷ heating surface	722
Total heating surface ÷ grate area	93.5
Firebox heating surface ÷ total heating surface	6.6
Weight on drivers ÷ total heating surface	56.8
Volume both cylinders	12 cu. ft.
Total heating surface ÷ vol. cylinders	259
Grate area ÷ vol. cylinders	2.78

CYLINDERS.

Kind	Simple

Diameter and stroke	21 x 30 ins.
VALVES.	
Kind	Balanced slide
Greatest travel	5½ ins.
Outside lap	⅞ in.
Inside clearance	0 in.
Lead in full gear	1-16 in.
WHEELS.	
Driving, diameter over tires	51 ins.
Driving, thickness of tires	3½ ins.
Driving journals, diameter and length	10½ x 13 ins.
BOILER.	
Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	80 ins.
Firebox, length and width	120 x 40 ins.
Firebox, water space	4, 4½ ins.
Tubes, number and outside diameter	430, 2 ins.
Tubes, length	13 ft.
Heating surface, tubes	2,906 sq. ft.
Heating surface, firebox	206 sq. ft.
Heating surface, total	3,112 sq. ft.
Grate area	33.3 sq. ft.
Smokestack, diameter	17½ ins.
Smokestack, height above rail	15 ft.
TENDER.	
Tank	U
Frame	Steel channel
Wheels, diameter	33 ins.
Journals, diameter and length	5½ x 10 ins.
Water capacity	7,000 gals.
Coal capacity	10 tons

RELATIVE MOVEMENT OF FIREBOX AND OUTER SHEETS.

In its report before the Master Mechanics' Association the committee on flexible staybolts cited a number of tests, which had been made to determine the relative movement of the firebox and boiler sheets, in their own plane, while heating the cold water to the working pressure temperature (AMERICAN ENGINEER, page 321, August issue). The greatest movement was obtained in a radial stay crown sheet where the difference in the movement of the two sheets amounted to almost 3-32 inch.

In discussing the report Mr. Max H. Wickhorst called attention to the fact that the relative movement of the two sheets would probably have been considerably greater, if they had been covered with scale instead of being clean. He said: "It strikes me that probably the main reason of the large movements of such sheets is the forming of scale, mud or other insulating material on the firebox sheets. I made some temperature tests which indicated that with a hot firebox, a ½-in. sheet cannot be raised above the temperature of the water more than 40 or 50 deg. F., but allow ⅛ in. of scale to form and the temperature of the metal will rise above the temperature of the water by several hundred degrees. In fact, with a hot fire and ⅛ in. of scale on the staybolts and sheets, the sheets can actually attain a low red heat. As the relative movement of the sheets is probably primarily, a function of the difference in temperature more than any one thing, it will be seen that if the temperature of the inside sheet is allowed to be materially increased, the movement is going to be greater, and I rather imagine that if the test had been made with scaled sheets, that a greater movement would have been found. For instance, by opening the fire door, after a good hot fire, with a temperature of the water say, 400 deg. or a little lower, the temperature of the firebox sheets would easily be raised to 600, 800 or 1,000 deg.; whereas, if the sheets are perfectly clean, their temperature probably would not have been raised to over 450 deg."

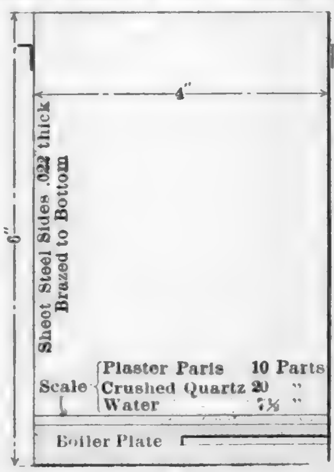


FIG. I.—APPARATUS USED IN MAKING TEMPERATURE TESTS.

The following description of the experiments made by Mr. Wickhorst and referred to above was given in a paper on "Firebox Steel—Failures and Specifications," presented by him at the recent meeting of the American Society for Testing Materials:

"In order to get some information concerning the temperatures actually attained by locomotive firebox sheets, etc., under conditions of service, I arranged to get an electric pyrometer consisting of a platinum thermo-couple and galvanometer, and the intention was to work the boiler at rates similar to service conditions, and insert the junction of the thermo-couple through a small hole drilled in a stay bolt, extending across to near the fire side. Tests of this kind have not as yet been made, but some preliminary results have been made with the apparatus shown herewith as Fig. 1. From this it will be seen that the method of test consists of boiling water in a can with thin sheet steel sides, with a bottom of half inch boiler plate, 4 ins. in diameter brazed to the sides. The boiler plate has a hole drilled into the side ⅛ in. in diameter extending to the middle of the plate. Heat is supplied by a specially constructed "pepper box" burner which gives a lot of gas flames over a flat circular area of about 4 ins. in diameter. The junction of the thermo-couple is inserted into the hole of the plate to the middle, and the temperature is read on a galvanometer. Some preliminary results are shown in Fig. 2, from which it will be noted that if a firebox sheet (including flue sheet) or the flues are free from scale or mud, the temperature of the metal probably does not at any time exceed the temperature of the water more than 50 deg. F., providing of course the circulation is sufficient to keep the water always in contact with the metal. Under the conditions of this experiment with no scale or water on the plate, the metal attained a temperature of about 1,300 deg. F., and it will be noted from the diagram that with ⅛ in. scale the metal attained a temperature of about 200 deg. above the temperature of the water; with ¼ in. something over 400 deg."

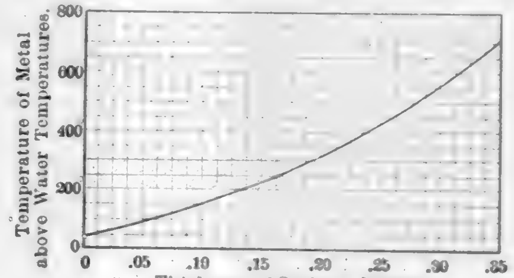
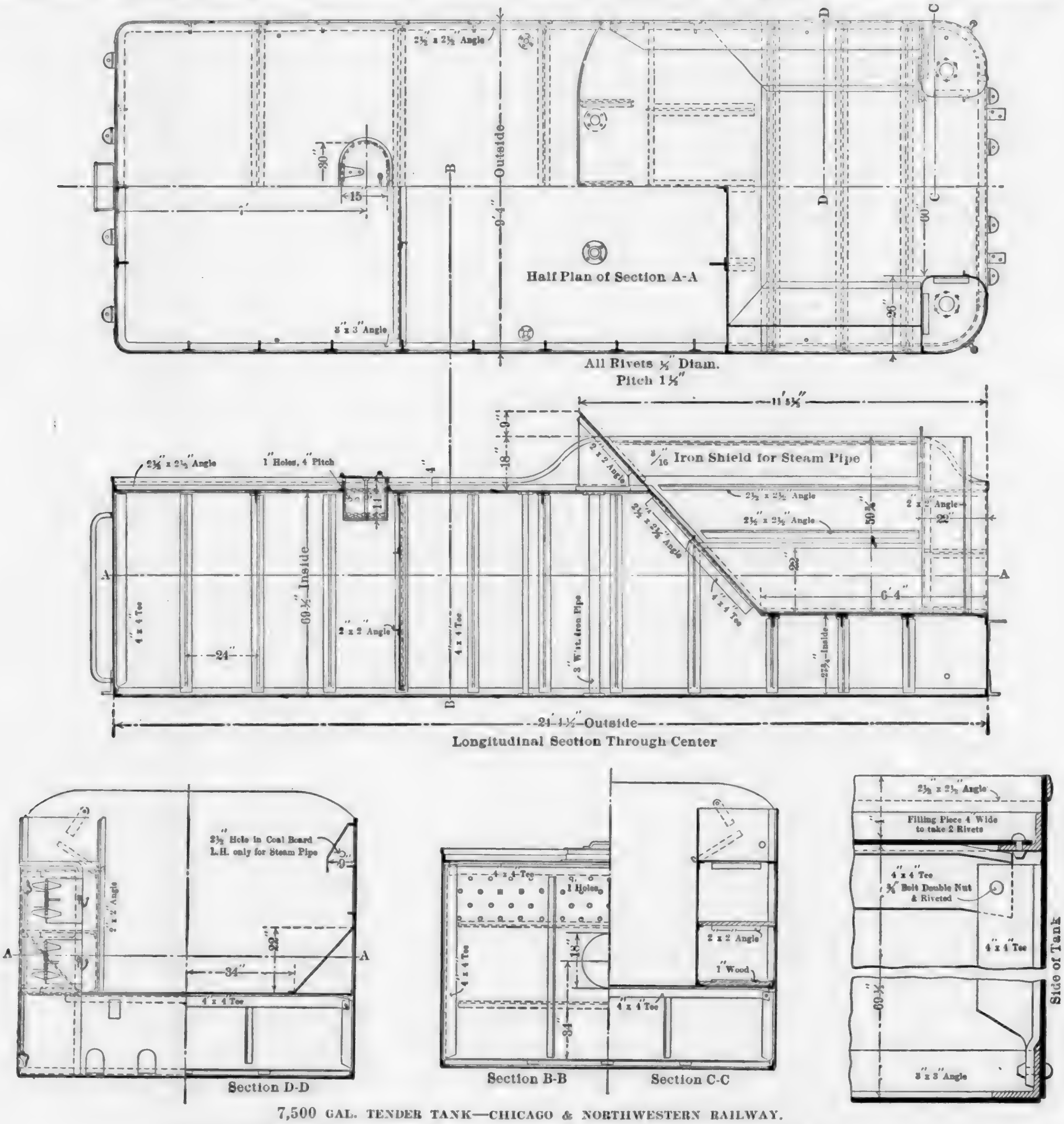


FIG. 2.—CURVES SHOWING VARIATION OF TEMPERATURE OF FIREBOX STEEL CAUSED BY VARIOUS THICKNESSES OF SCALE.

"In a locomotive firebox, the average temperature of the metal, if not protected by the water, would probably run between 2,000 and 3,000 deg. F., and with scale ⅛ in. thick and with water in the boiler, the experiments indicate that the metal including firebox ends of the tubes, can readily attain a temperature of several hundred degrees above the temperature of the water, and it is not unlikely in some cases the metal actually attains a low red heat."

THE LOCOMOTIVE PROBLEM.—Heretofore the locomotive has grown chiefly in size, weight and power, but there remains another development in the direction of crowding the greatest possible capacity for power within the possible limits of weight and size. Economy of operation, while important, is less important to-day than the provision of the utmost possible capacity of the machine. Perhaps this may be more clearly stated by saying that the greatest need is for that which will extend to the utmost the capacity of the fireman and render the limited physical strength of a man capable of supplying the requisite power.—*Mr. G. M. Basford, at Purdue University.*



7,500 GAL. TENDER TANK—CHICAGO & NORTHWESTERN RAILWAY.

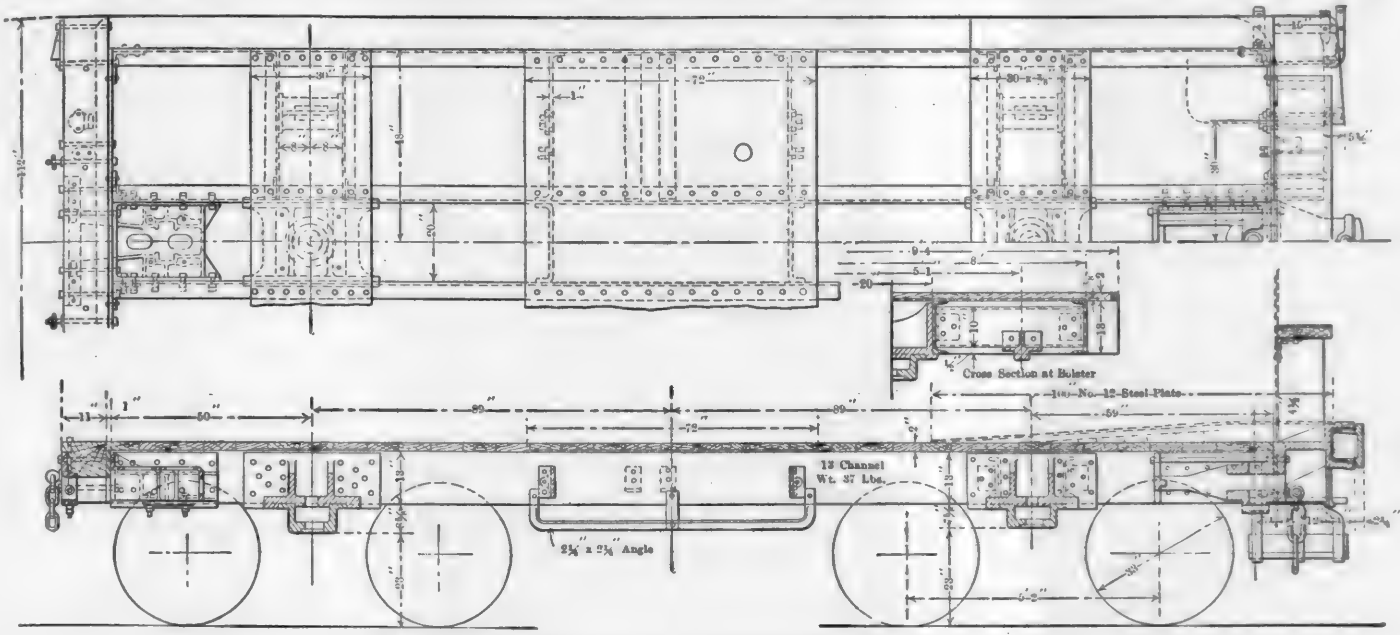
LOCOMOTIVE TENDER.

CHICAGO & NORTHWESTERN RAILWAY.

The Chicago & Northwestern Railway has just designed and is placing in service a new tender tank with a capacity for 7,500 gals. of water and 10 tons of coal. As may be seen from the drawings, the coal space extends the full width of the tank, thus making it possible to bring the entire coal supply within easy reach of the fireman. The sides and top of the tank are stiffened by 4x4-in. T's, the T's at the top being tied to those on the sides by a ¾-in. bolt, as shown in the small detail drawing. Except for these and the one baffle plate there is no cross or longitudinal brace of any kind inside the tank, nor is the bottom of the tank stiffened in any manner except at the edges, where it is attached to the sides by the 3 by 3-in. angles.

It is the custom on this road to use different heights of body center pins at the two trucks in order to have the floor at the rear end of the tank one inch higher than at the front end, thus permitting all the water to flow toward the front end. For this reason the 3-in. wrought iron drain pipes are placed as far forward as possible. The steam pipe from the engine to the train heating line is protected by a shield as it passes through the coal space. The intake is fitted with a well 14 ins. deep, the bottom of which consists of perforated plate such as is used in smoke boxes, and the sides of the well have a number of 1-in. holes punched in them as shown.

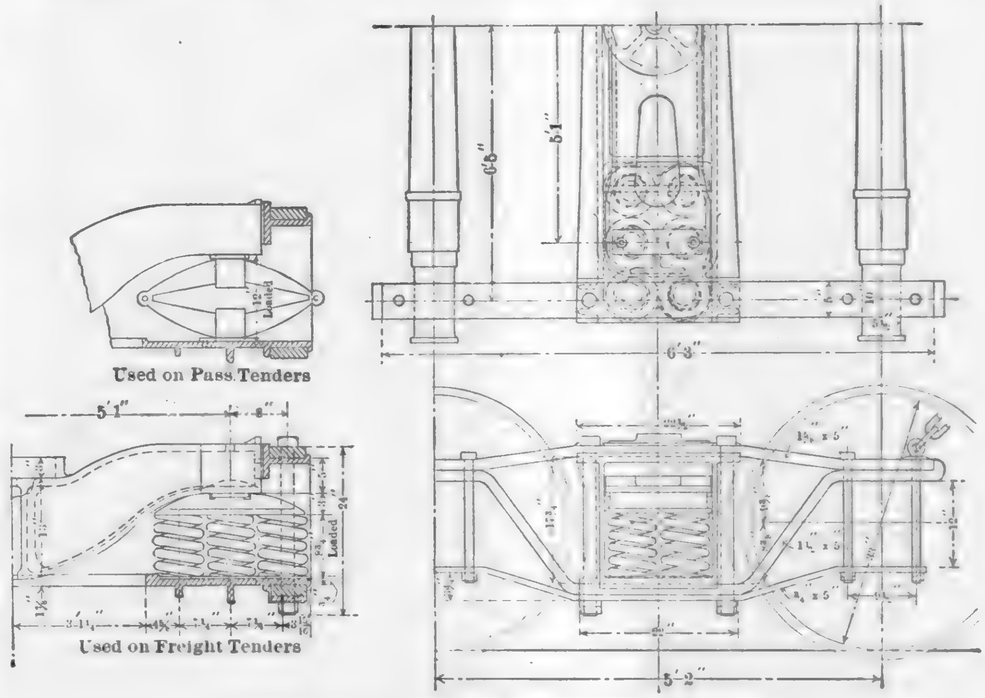
The center and side sills of the tender frame are 13-in., 37-lb. channels. The center sills are tied together at the bolsters by a heavy casting, and the center sills are connected to the side sills at this point by 10-in. channels as shown, a ⅜-in. cover plate, 30 ins. wide, extending over the top and tieing the members securely together. There is also a ⅜-in. top cover plate 72 ins. wide at the center of the frame, and, in addition, the center sills near each end of this plate are tied together by a 1 by 8-in. wrought iron U plate as shown. A spring buffer is used between the engine and the tender, and



TENDER FRAME—CHICAGO & NORTHWESTERN RAILWAY.

the drawbar connection at the rear of the tender is rigid and not equipped with spring or friction resistance. This frame, as well as the 7,500-gal. tank, is standard for both passenger and freight service. To adapt a tender frame used in one class of service for the other, it is only necessary to change the center pins, which can easily be done.

The truck, which except for the springs is standard for both classes of service, is of the arch bar type with a wheel base of 5 ft. 2 ins., and 5½ by 10-in. journals. Thirty-three-inch wheels are used in freight service and 36-in. wheels in passenger service. The transom and the bolster are both of cast steel made by the American Steel Foundries Company. The trucks for the passenger tender are equipped with elliptical springs, but may readily be adapted to freight service by substituting the helical springs and equalizing plate as shown in the drawing. We are indebted for drawings and information to Mr. R. Quayle, superintendent of motive power and machinery, and Mr. W. E. Dunham, mechanical engineer.



TENDER TRUCK—CHICAGO & NORTHWESTERN RAILWAY.

American Car & Foundry Company.—The report of the president of this company states that during the year ending April 30, 1906, it built 73,540 cars, of which 72,757 were freight and 783 passenger. Of the freight cars, 38,239 were of wood and 34,518 of steel construction. Of the 783 passenger cars 564 were wood and 219 steel. The company also made 949,951 car wheels.

Two-Story Elevated Cars.—The German Society of Mechanical Engineers offers a prize of 6,000 marks for an effective working out of a scheme for two-story cars for the Berlin elevated railroad, the upper story to be entered from special station platforms. The necessity for this arises because of through trains which pass through the city over the same tracks and interfere with the urban traffic, which requires more trains than can be put on the road.—*American Machinist.*

Master Car and Locomotive Painters' Association.—The thirty-seventh annual convention of this association will be held at the Hotel Arlington, Washington, D. C., September 11, 12, 13 and 14. Among the reports to be considered are: The Lustre and Life of Varnish—(To what extent is it affected by the different colors, pigments and metals? Why do varnishes lose their brilliant gloss and crack? Can remedies be applied to overcome this trouble?); Canvas Roofs for Passenger Equipment—(Is it a benefit to use felt paper under the canvas? How should a new canvas roof be painted?); The Well Equipped Sand-Blast as a Factor in the Labor-Saving Economy of the Railway Car and Locomotive Paint Shop; The Painting of Freight Equipment—(What are the best methods and most suitable colors for painting and stenciling the different classes of freight cars? What parts should be painted for their proper protection and appearance?); Is it to the Advantage of Railroad Corporations to Manufacture the Paints and Varnishes which they Consume?; The Apprentice System in the Railway Paint Shop—(Is it receiving the attention which it merits?); Brushes, their Selection, Care and Keeping.

(Established 1832).
AMERICAN ENGINEER AND RAILROAD JOURNAL.
PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE.

J. S. BONSALL,
Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT, E. A. AVERILL, Editors.

SEPTEMBER, 1906.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*
Remit by Express Money Order, Draft or Post Office Order.
Subscription for this paper will be received and copies kept for sale by the
Post Office News Co., 217 Dearborn St., Chicago, Ill.
Damrell & Upham, 283 Washington St., Boston, Mass.
Philip Roeder, 307 North Fourth St., St. Louis, Mo.
R. S. Davis & Co., 346 Fifth Ave., Pittsburgh, Pa.
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W. Dawson & Sons, Ltd., Cannon St., Bream's Buildings, London, E. C., England.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase of construction.*

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When a subscriber changes his address *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

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A great deal of attention has been given to improving conditions on the machine side of the locomotive repair shop and possibly not enough to the erecting side of the shop. In some of the more progressive shops a plentiful supply of portable electric and pneumatic tools have been introduced with splendid results, and these with other devices, such as special blocking jacks, lye vats, etc., and in connection with the introduction of repair schedules and improved organization, have done much to place the erecting shop on a par with improved machine shop practice and to very materially increase the output of locomotives per pit per month. One of the first roads to introduce a shop schedule was the Chicago & Northwestern at their Chicago shops. This schedule was described on page 58 of our February, 1904, issue. and the results which were gained by its introduction were considered on page 73 of our March, 1905, issue. On page 159 of our May, 1905, issue the shop schedule in use on the Boston & Maine Railroad at the Concord shops was described. These schedules must, of course, be arranged to suit local conditions, and in every instance where they had been worked up carefully the results which have been obtained have astonished those in charge.

A schedule which has given exceptionally good results on a Western road is described by Mr. C. J. Morrison on page 338 of this issue. The shop is operated on what is known as the "gang method," and while some roads do not look upon this method with a great deal of favor, it seems to have given very satisfactory results in this instance. After all, the matter of improving the shop output depends entirely on the organization, and as labor conditions and the condition of the equipment differ in each shop, the best results can only be obtained by very carefully studying the problems involved and carefully improving the organization and introducing a repair schedule and a satisfactory cost keeping system.

THE AGE OF A MAN.

When a man is past the age of thirty-five years he is likely to begin to think of the days when he must reduce his pace, because of increasing years, and if he is a thoughtful man he is likely to be somewhat anxious as to what he will do when he is "old." After the age of forty it begins to be difficult to secure a new position for one who is unexpectedly required to do so. Young men are in demand, and few employers willingly take on any but young men.

This is perfectly natural, and to a certain extent this feeling about young men and the fear of becoming old is justified. When a man much past forty applies for a position an employer wonders why he is seeking employment if he is a good man, and if he has made proper use of his opportunities. It is quite possible that young manhood may be passed under conditions preventing the proper and natural development and advancement which one's capabilities warrant, and in the preference given to young men the employer may incur a danger of missing some excellent opportunities.

Considering workmen in the shop up to the age of, say, thirty-five, virility, spring, vigor and physical strength are likely to take the place of brain effort. Brute force is then more prominent, the tendency being to add a little speed rather than to give careful attention to the shape of tools or to use the thought and the care which counts so much towards making brute strength unnecessary. The man past thirty-five is more likely to reach for the air hoist, to look after the best possible shape of the tool and to keep the tool sharpened. He experiments in various ways to quicken the cut. He studies out and makes jigs to lay out the work, reducing unproductive time of the machine. Devices come into play to quickly set the work, and attachments are made to hold it for heavy cuts. Physical strength at this stage of life is not usually waning, but the mind is busy because of experience which has shown how a little thought may save physical effort.

At whatever age thought begins to replace thoughtless exertion of brute strength, at that age a man becomes steadier,

better and less "quick on the trigger"; at that age he is likely to listen a little less to an exhorter who has his own interests to accomplish. He is likely to think more of the real responsibilities of life and his responsible relationships towards those who furnish him work, and to think more of the home, and those in it for whom he works. When a man begins to realize that there will come a time when he cannot work at all he should, if properly intentioned and right in his life, be more valuable than ever before. At this stage he is really on the up-grade, and grows better every year to a much later age. If such a man seeks employment at your shop you may miss your own opportunity if you look at his number of years and say that you want younger men.

These paragraphs were inspired by a conversation with a most successful manager of a plant employing many men, the manager himself being, perhaps, fifty years of age. If this manager (which is impossible) should seek a new position his age would scarcely be thought of, because of his success in doing that which few are able to do, viz., direct the work of several thousand men to continually improve their efficiency and set a pace which thus far few, if any, have ever attained. That this success has been attained is largely due to a knowledge of men and the realization of the fact under discussion, which is, that men are often more valuable after reaching the age of maturity.

SUGGESTIONS CONCERNING THE M. M. AND M. C. B. ASSOCIATIONS.

There can be no question concerning the great importance of the work which has been accomplished by both the Master Car Builders' and the American Railway Master Mechanics' Associations. It is due to the efforts of the Master Car Builders' Association that freight cars may be interchanged over roads in every part of the country, and that they are operated with such a great degree of safety. The value of its work is appreciated not only by the railroads themselves, but by the Federal Government. The national laws concerning the safety devices on cars are based entirely upon the rules adopted by the Master Car Builders' Association. To the Master Mechanics' Association is due in a very great degree the many improvements in the design, operation and maintenance of locomotives and the improvement in the efficiency of the motive power department.

The importance of the investigations pursued by these associations is many times greater than it was a few years ago, when the number of cars and locomotives was very much smaller and the railroads were not forced to operate them with as great a degree of economy as at present. In spite of the greater importance of the work which is being carried on, we find that the amount of time which is devoted to the discussion of the various subjects by these associations is not any greater now than it was when very much less work was handled, and the method of holding the convention is much the same as formerly. If the associations are to keep up their good work it would seem that they must be handled in a very different manner from what they are at present.

In the first place, the committee reports and individual papers should be sent to the secretary of the association early enough so that he can place copies of them in the hands of every member of the association at least three weeks before the convention. Even this is not time enough for the average member to properly read and digest such of the reports as he is especially interested in. It requires considerable effort on the part of the motive power officer to get his work into such shape that he can attend the conventions, and if the papers do not reach him until only a few days previous to his leaving the rush of work is so great that he cannot give them the proper amount of time and attention. It is a lamentable fact that members very often take up considerable time upon the floor which might very well have been saved if they had had time or taken the pains to study the report carefully.

Every report or paper, unless it is extremely brief, should be presented in abstract. These abstracts should be very brief, and the time for presenting them should be limited to a very few minutes. Under ordinary circumstances they should be read by the secretary of the association, or if by a member of the committee, he should be a proficient reader, with a good, strong voice. At the recent conventions most of the reports were read entire, and in most cases where it was attempted to present abstracts they were entirely too long. In some instances the reports were so poorly read that only a few people within a short distance from the reader were able to follow him, and then it required an effort. The noise made by the squeaking of the chairs, the passing of the members back and forth over the bare floor, and the noise from the exhibits outside of the meeting room, added in many instances to poor reading, were extremely disagreeable features. In many instances a large number of the members present paid very little attention to what was going on while the report was being read, and acted as if they were very much bored until the reading was closed and the discussion opened.

Apparently the members who took the most active part in the discussions were those who had had time to study the reports beforehand. The reading was, therefore, not of much interest to them. The other members, unless they were extremely familiar with the subject, could not gain much from the hurried reading in the convention. In order to have the abstracts uniform and suitable it would doubtless be a good idea to have the secretary of the associations prepare them.

A feature which should be strongly condemned, and which should be carefully guarded against in the future, is that of having a report read by title and passed without discussion, owing to lack of time or the absence of the members of the committee who drew up the report. Nothing should be allowed to interfere with the program as arranged by the executive committee. The proper consideration of the reports, many of which involve considerable investigation, which is carried on at a great expense to the railroads upon which the tests are conducted, is of very much greater importance than any features of entertainment which may be provided, and these features should not be allowed to interfere with the program as arranged by the executive committee.

There is no question but what the discussions would be very much more valuable if the meetings were held in a room with good acoustic properties and far enough from the exhibits so that the noise made by them will not interfere. More machinery and equipment in operation is shown at each succeeding convention, and the noise made by such exhibits is becoming greater each year. It is not necessary for the meeting hall to be so placed that members must pass by the exhibits in going to and from the meeting. In most instances the members are just as anxious to see the exhibits as the exhibitors are to have them.

The executive committee should also see that comfortable chairs are provided. Many of the members wish to remain in the convention during the entire session, and if conditions are at all favorable will do so. It must be admitted that sitting on a folding chair for three or four hours or more is not the most comfortable thing in the world, and if such chairs are squeaky and make a racket every time a man changes his position it is rather disconcerting. It often becomes necessary for a member to leave during the session, and supply men often wish to come in to hear the discussion of the reports in which they are specially interested, and in order that such movements may be made without disturbing the meeting rugs, or some suitable covering, should be placed upon the floor, at least upon the aisles. The attendance at the conventions seems to be increasing, and the seating capacity in the meeting room at the last convention was in several instances not large enough to accommodate those present.

If these associations, of which we may well feel proud, are to improve and progress in line with the growth and increasing importance of the motive power department, immediate measures should be taken to improve such conditions as those mentioned above.

SOUTH ALTOONA FOUNDRIES.

PENNSYLVANIA RAILROAD.

(*Continued from page 126*).

GREY IRON FOUNDRY.

The main structure is about 564 ft. by 163 ft.; it has an extension on one side about 444 ft. long by 60 ft. wide, which contains the office, wash room, sand mixing room, core room and a room for the temporary storage of patterns. The illustrations give some idea of the structural steel work and of the splendid daylighting. The main part of the building is divided into three longitudinal bays. The two side bays are 45 ft. wide, and are spanned by 5-ton electric traveling cranes, which are operated from the floor. The center bay is 70 ft. wide, and is spanned by one 25 and two 12½-ton electric traveling cranes, the runways of which extend 280 ft. beyond the building at each end. The ends of the building are so arranged that these traveling cranes may run out on this extended runway, beneath which are stored the flasks and heavy castings. The brick walls, except for a doorway 12 ft. wide at the center, are carried up to the height of the crane runway, and above this the opening is closed by a lifting door, which extends across the entire width of the bay. This door is made of corrugated steel, and is arranged to swing inward and upward, the mechanism being operated by an electric motor. In addition to these cranes there are a number of 5-ton jib cranes attached to the columns along the sides of the center bay, resting on pintles so that they can be moved from one column to another by the overhead traveling crane.

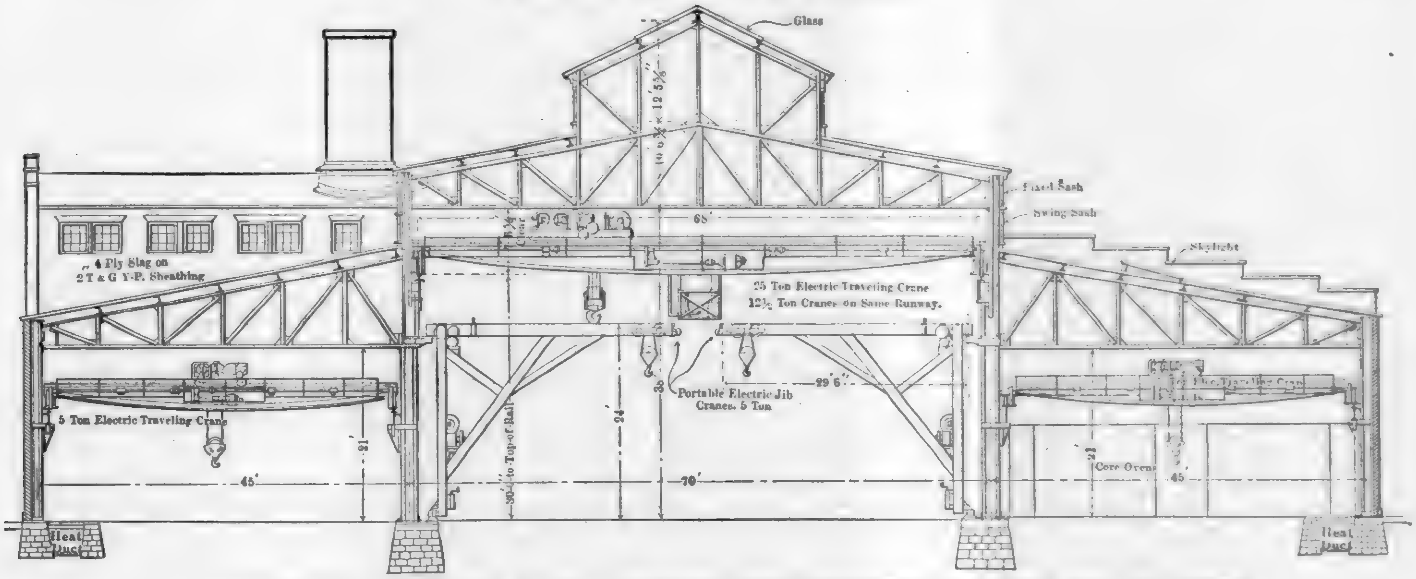
There are two 96-in. cupolas which have a capacity of 18 tons an hour. It was the intention to provide four of these, as shown on the drawing, but only two have been installed, one at each end. The cupola at the center is smaller, and is used principally for cylinder iron. The arrangement of the blowers, cupolas and charging rooms is practically the same as those in the wheel foundry. That part of the west bay which lies between the cupola and the end of the foundry nearest the pattern shop will be devoted entirely to an extensive installation for the machine moulding of small castings. The waste sand will drop down through iron grates and will be conveyed to a sand mixing machine made by the Standard Sand & Machine Company of Cleveland. This machine mixes

GREY IRON FOUNDRY, WITH WHEEL FOUNDRY AT THE LEFT—SOUTH ALTOONA FOUNDRIES.

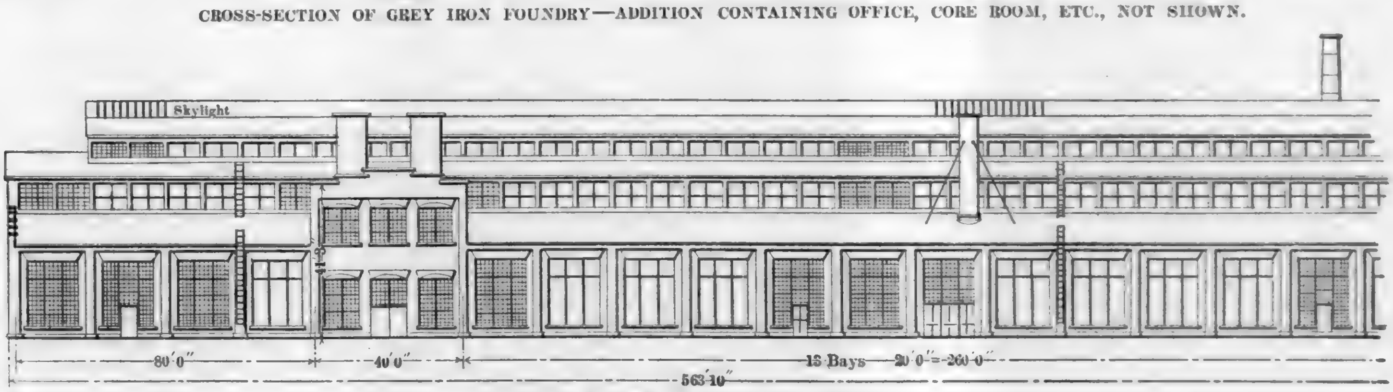
INTERIOR OF THE GREY IRON FOUNDRY—SOUTH ALTOONA FOUNDRIES.

and cleans the sand and conveys it overhead, from whence it will be fed down through spouts to the moulding machines. The other end of the foundry is given over entirely to the cleaning of the castings; in it are four batteries of tumblers, each containing three units; each battery is driven by a 20-h.p. motor. All the cleaning is done over a grated floor, and the burned sand drops through into a tunnel and is received by small cars. These are hauled out when they are filled by a small electric locomotive. The track from the tunnel runs to a trestle near the office building, where the cars are dumped into wide-gauge cars without rehandling the material.

END VIEW OF THE GREY IRON FOUNDRY.



CROSS-SECTION OF GREY IRON FOUNDRY—ADDITION CONTAINING OFFICE, CORE ROOM, ETC., NOT SHOWN.



PART SIDE VIEW OF GREY IRON FOUNDRY.

The core ovens are located in the east bay, adjacent to the core room. The furnaces for these ovens are located below the floor level. The shelves for the cores are on cars, and the tracks extend out into the core room. Below the core room, which has a cement floor, are sand storage bins, from which the sand is raised in narrow-gauge cars by an hydraulic elevator. The core benches and the core racks are built entirely of steel, as shown in the illustrations.

The sand mixing room is equipped with an electric driven sand mixing machine made by the Standard Sand & Machine Company. The sand is raised from the storage room in the basement by an hydraulic elevator, and is emptied into overhead storage bins, and from these it is fed into the mixing hopper of the machine. After being properly mixed and cleaned it is conveyed to storage bins. A room, 60 by 100 ft., adjacent to the core room, is used for the storage of patterns which are in use in the foundry.

The wash room, 60 by 120 ft., is equipped with metal lock-

SOUTH ALTOONA FOUNDRIES.

PENNSYLVANIA RAILROAD.

(*Continued from page 126*).

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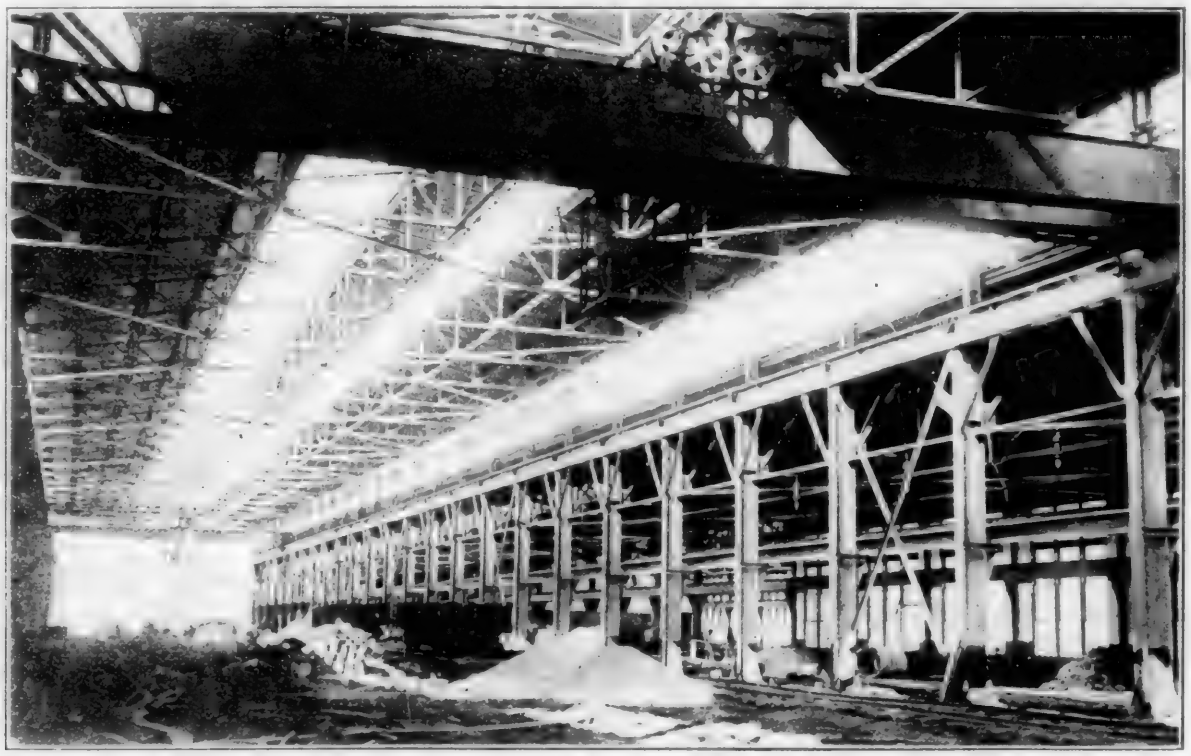

INTERIOR OF THE GREY IRON FOUNDRY—SOUTH ALTOONA FOUNDRIES.

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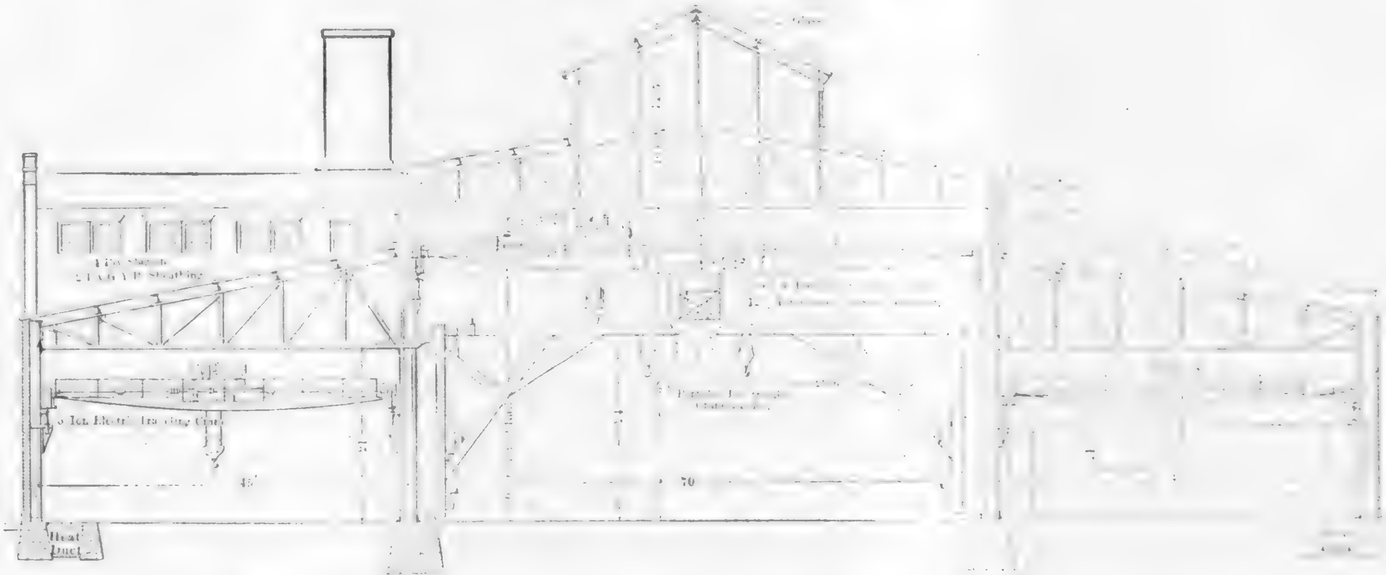

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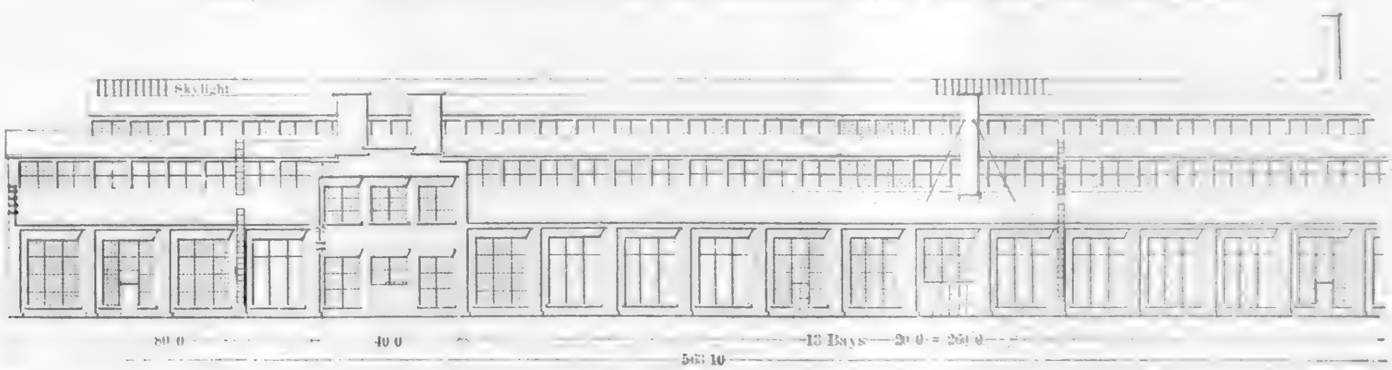

PART SIDE VIEW OF GREY IRON FOUNDRY.

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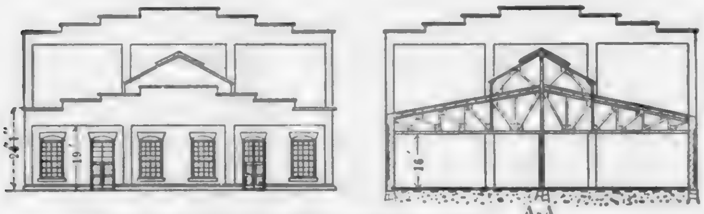
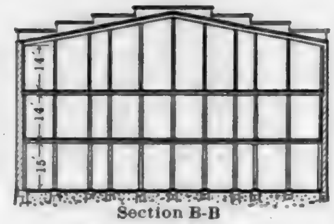
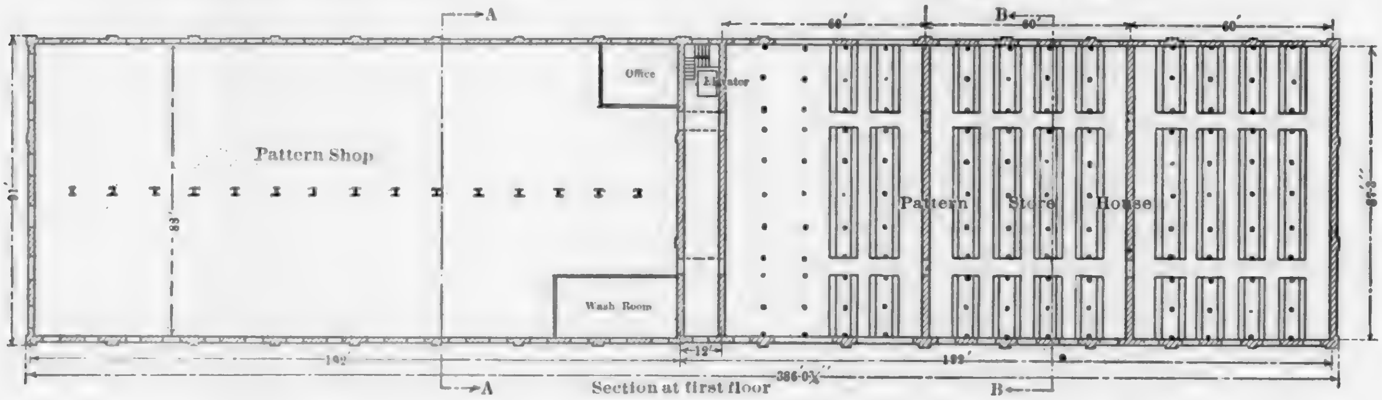


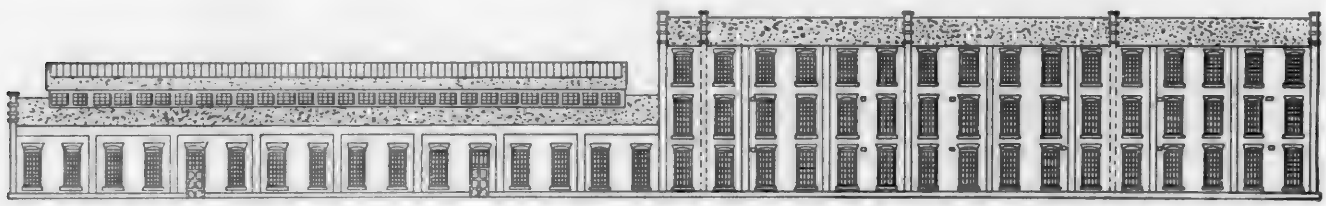
End elevation and section of Pattern Shop A-A



Section B-B
Pattern Store House



Section at first floor



PATTERN SHOP AND PATTERN STORAGE BUILDING.

ers, shower baths and large porcelain wash basins, with hot and cold water faucets. The room is well lighted and has a cement floor.

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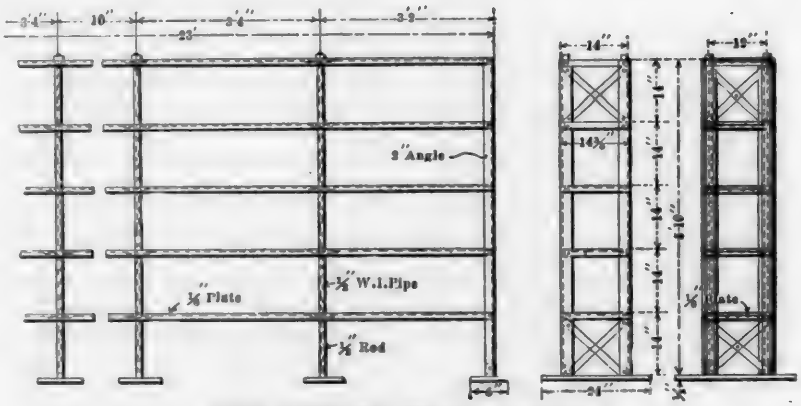
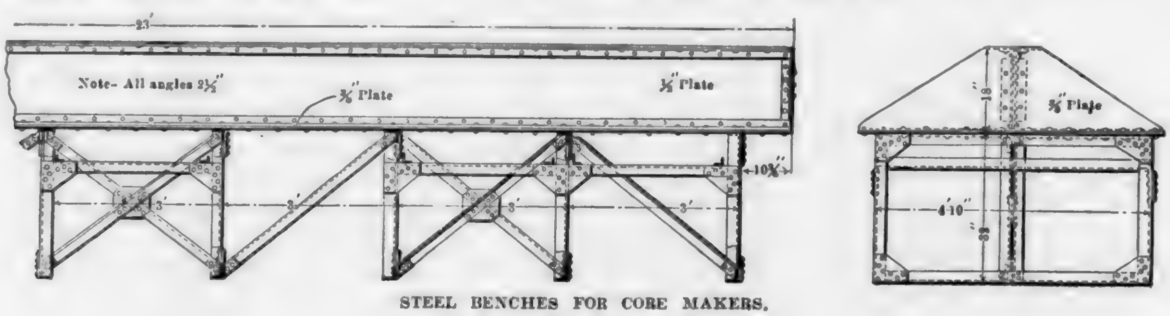


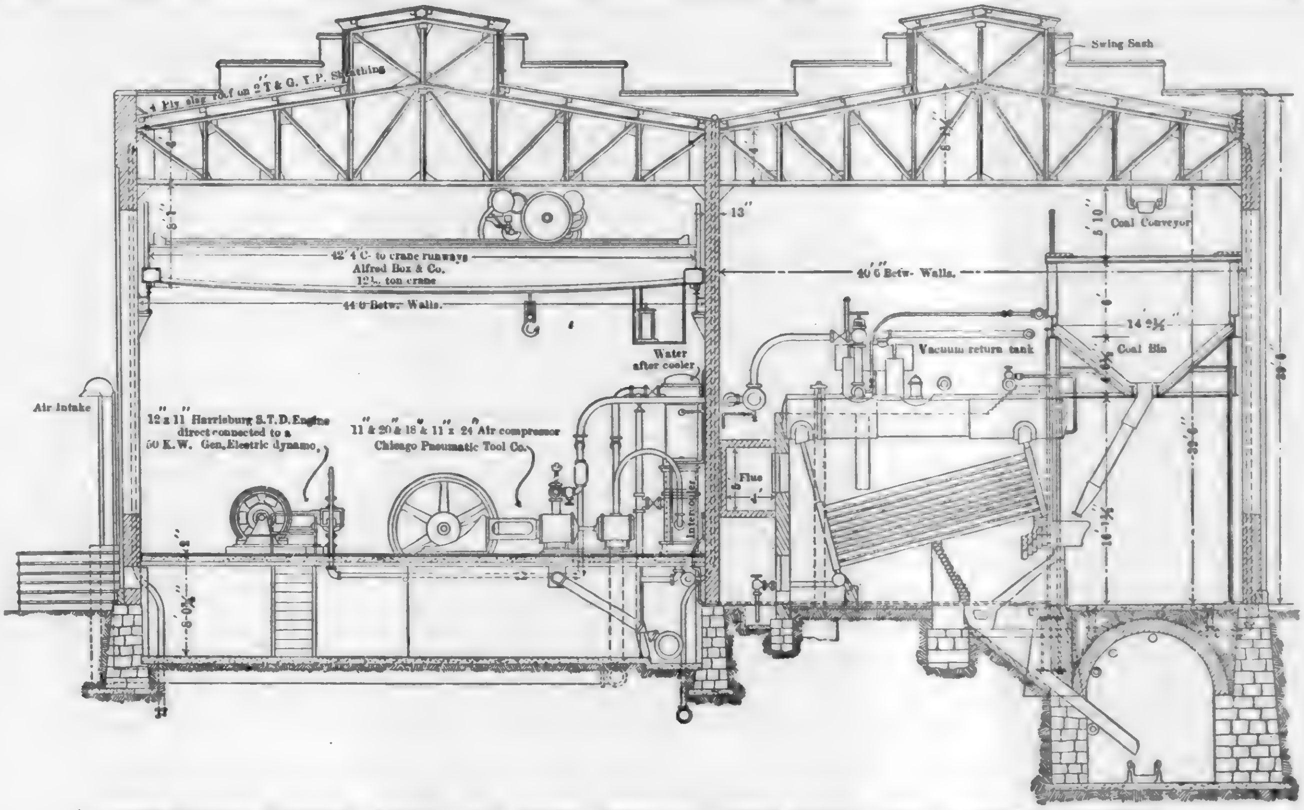
STEEL RACKS FOR STORAGE OF CORES.

LIST OF PATTERN SHOP MACHINERY.

Name.	Size of Motor.
Rip saw, 36 by 72 in. table, P. R. R.	5½ h.p.
Rip saw, 48 by 76 in. table, L. Wright	3½ h.p.
Band saw, Berry & Orton	2½ h.p.
Band saw, type B, with ½ in. saw blade, Oliver	3½ h.p.
Putnam lathe, 25 and 50 in. swing, 8 ft. bed	25 h.p.
Power band saw filing and setting machine, Atlantic Works	
Drill press, P. R. R.	
Crane core box machine, J. A. Crane & Co.	
28 in. grindstone	
30 in. automatic knife grinder, No. 40, Springfield Mfg. Co.	
20 in. by 6 ft. 9 in. lathe, P. R. R.	
30 in. by 11 ft. lathe, P. R. R.	
30 in. by 22 ft. lathe, P. R. R.	
90 in. face lathe, P. R. R.	
Band saw, type B, with ½ in. saw blade, Oliver	3½ h.p.
Oliver Universal saw bench, 14 in. saw	3½ h.p.
Oliver Universal saw bench, 14 in. saw	3½ h.p.
20 in. hand planer and jointer, Oliver	3½ h.p.
Buzz planer and jointer, L. Power & Co.	3½ h.p.
24 in. heavy planer and surfacer, Atlantic Works	5½ h.p.
Oliver face plate lathe, type D	3½ h.p.
30 in. planer, R. Ball & Co.	5½ h.p.



STEEL BENCHES FOR CORE MAKERS.



CROSS-SECTION THROUGH ENGINE AND BOILER ROOMS OF POWER HOUSE—SOUTH ALTOONA FOUNDRIES.

HAND MACHINES.

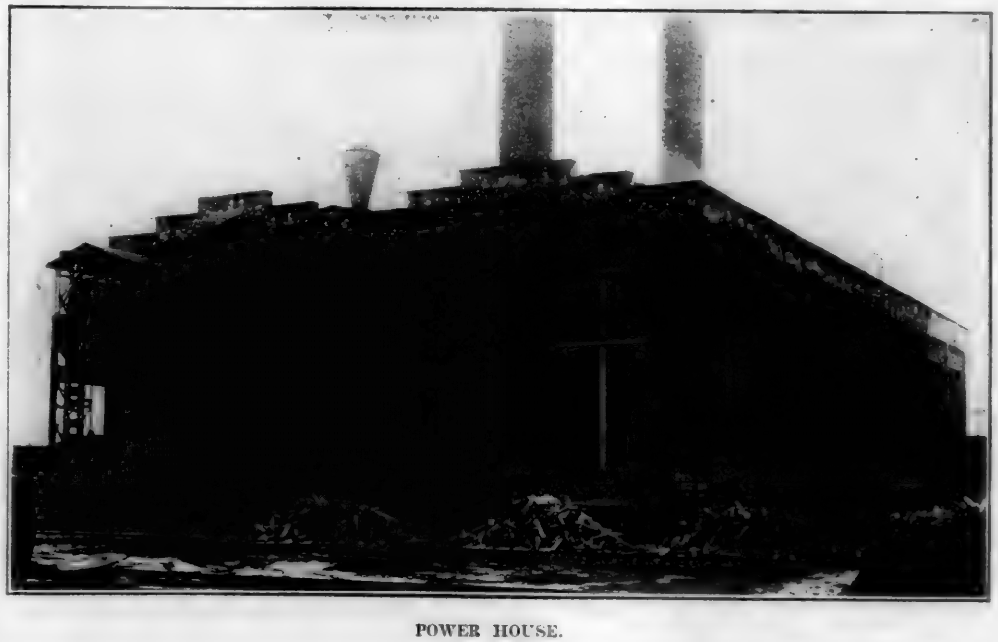
4 —No. 3 Oliver wood trimmers.
10—No. 1 Universal wood trimmers, American Woodworking Machinery Co.
4 —No. 4 Wood trimmers, Smith & Egge.

The shop is lighted by 32 enclosed arcs, and each work bench is provided with a 16-candle power incandescent light.

The pattern storage section is separated from the pattern shop by a 12-ft. hallway, which contains the elevator and stairways. The framework of this part of the building is of heavy timber construction. It is divided by brick walls into three sections, and the doors between these sections are of steel and are normally closed.

This department is equipped with a very complete telephone service. The men in charge have different numbers, and when they are called up every 'phone in the department sounds the number, so that a man can very quickly and easily be located. This part of the building is also equipped with sprinkler service, which is operated by valves placed outside of the building. Openings are made in the side walls at each floor to prevent the floor from being overloaded in case one of the rooms is flooded. Each section is also provided with fire extinguishers and fire hose. This part of the building is lighted by incandescent lights.

All of the patterns except the very large ones are stored on shelves, and are so arranged that they may readily be located by means of a card index system, and can easily be returned to their proper place on the shelves. A narrow-gauge track extends from this department to the foundries, as may be seen by reference to the general plan (page 122).

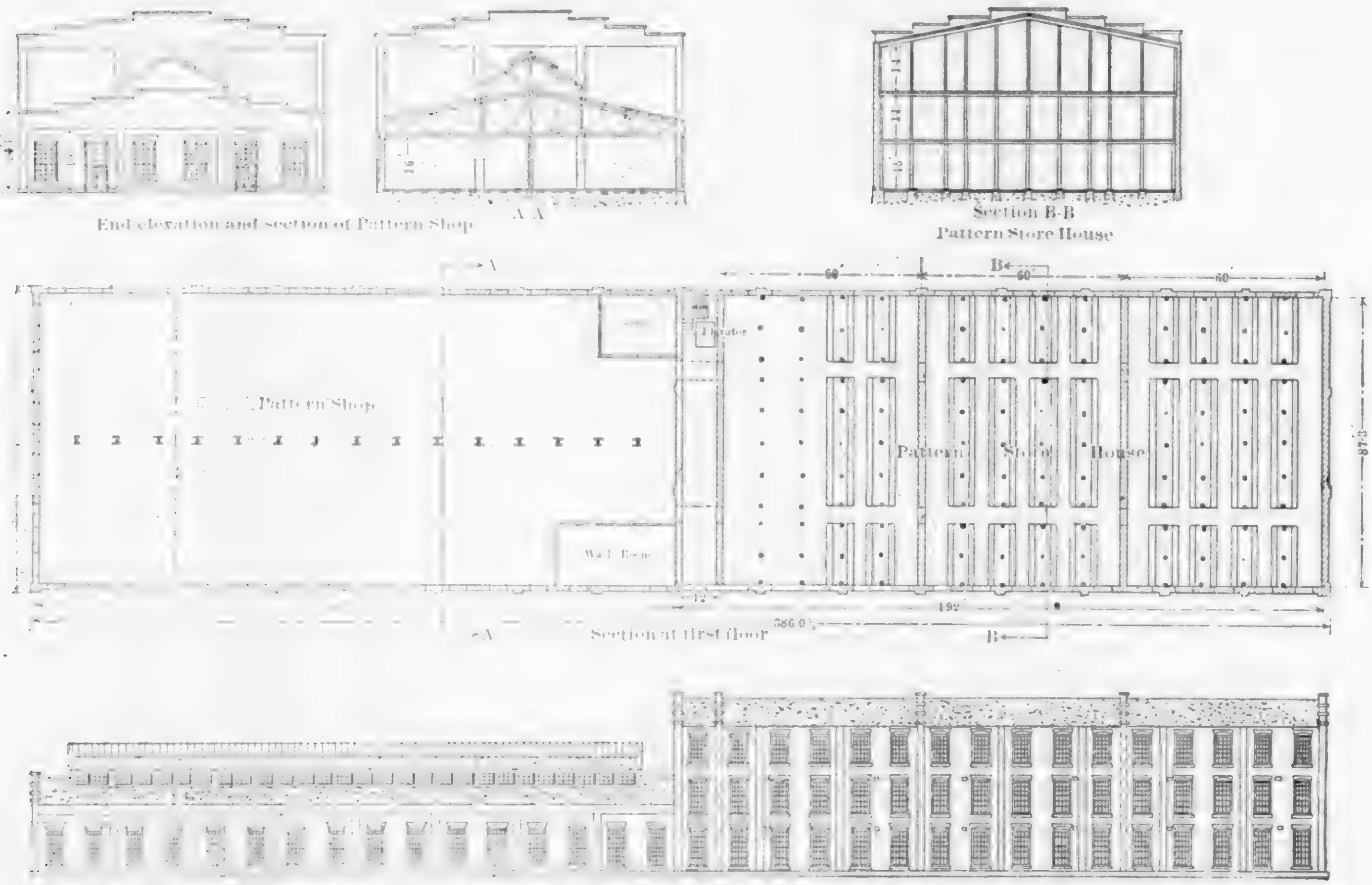


POWER HOUSE.

PATTERN SHOP AND PATTERN STORAGE BUILDING.

POWER HOUSE.

The power house is located at about the centre of gravity of distribution when the brass and steel foundries will have been added to the present installation. The building has concrete foundations, brick walls and steel frame, and one end has a temporary wall of corrugated



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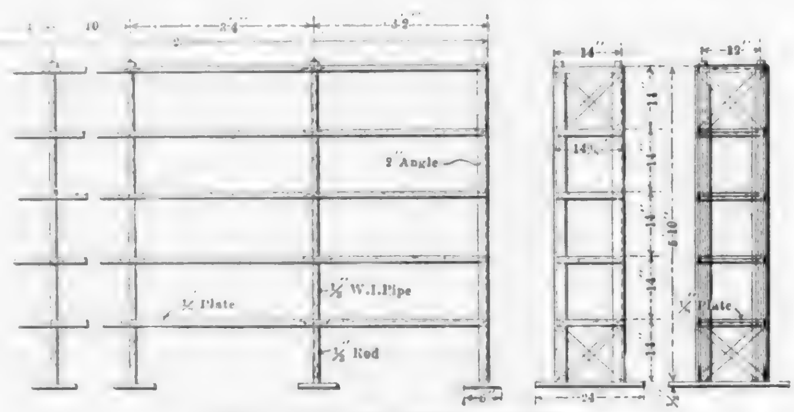

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Name.	Size of Motor.
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Band saw, type B, with ½ in. saw blade, Oliver	$3\frac{1}{2}$ h.p.
Putnam lathe, 25 and 50 in. swing, 8 ft. bed	
Power band saw filing and setting machine, Atlantic Works	
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Crane core box machine, J. A. Crane & Co.	
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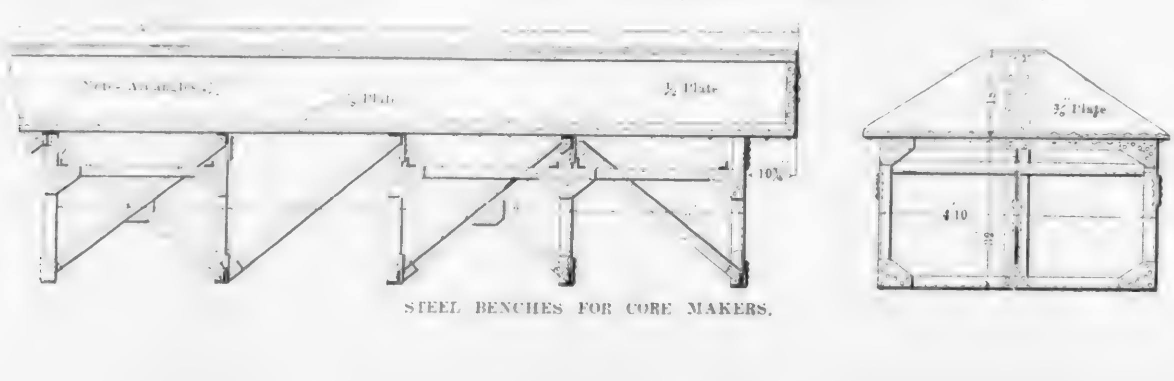
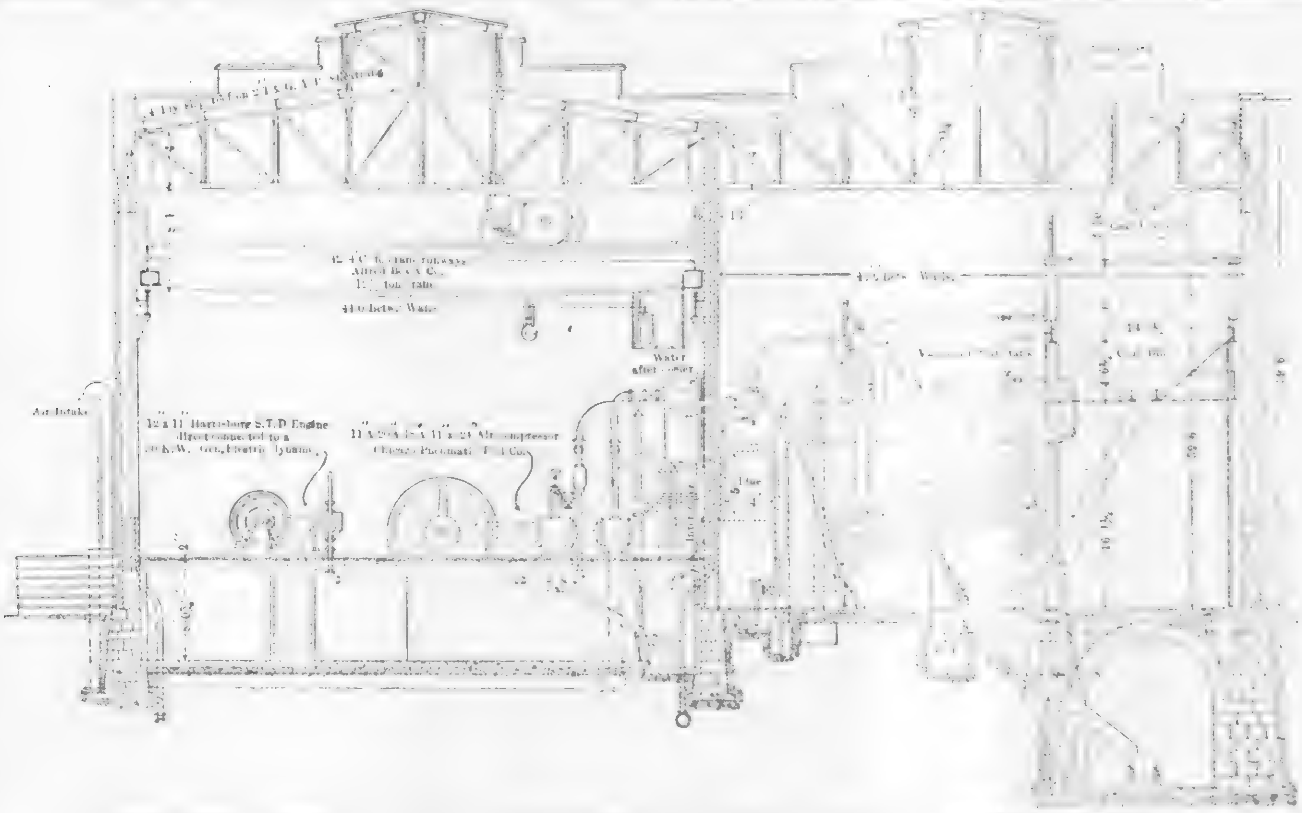


STEEL BENCHES FOR CORE MAKERS.



CROSS-SECTION THROUGH ENGINE AND BOILER ROOMS OF POWER HOUSE—SOUTH ALTOONA FOUNDRIES.

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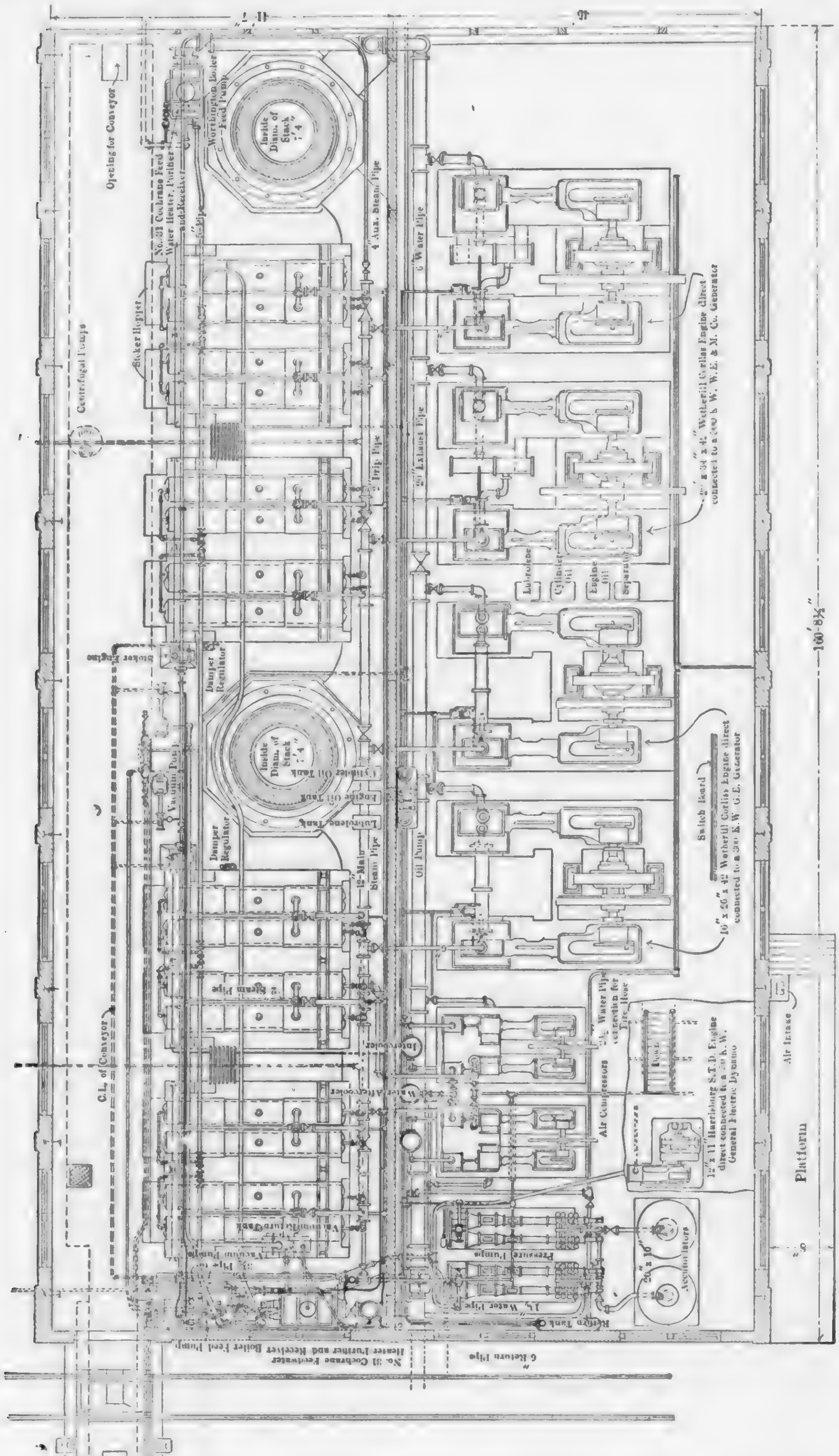


PLAN OF ENGINE AND BOILER ROOMS—SOUTH ALTOONA FOUNDRIES.

iron, so that it can readily be extended when the plant is enlarged. The house is divided by a 13-in brick wall into a boiler room 44 ft. wide and an engine room 40 ft. 6 ins. wide.

In the boiler room are eight 261-h.p. Babcock & Wilcox boilers equipped with Roney stokers. The draft is furnished by two steel stacks, 7 ft. 4 ins. inside diameter and 175 ft. high. Coal is delivered directly from hopper bottom cars to a Link Belt conveying apparatus fed by a reciprocating feeder, and is stored in a large continuous steel bin above the boilers, from which it is fed to the stokers. The conveying and coal-crushing apparatus is driven by two 10-h.p. motors installed in the boiler room basement. The ashes are conveyed to a bin above the coal delivery track, and are loaded from this directly into hopper cars. Two 3-in. motor-driven centrifugal pumps drain the water collected in sumps in the ash tunnel below the sewer level. The boilers are fed by three 12 by 7½ by 10-in. Worthington boiler feed pumps. The feed water is heated by two No. 31 Cochrane 1,700-h.p. feed water heaters, purifiers and receivers. Two 8 by 14 by 16-in. vacuum pumps are used in connection with the Warren-Webster system of steam circulation.

In the engine room are two 20 and 34 by 42-in, Wetherill-Corliss engines, direct connected to 500-k.w. Westinghouse generators, and two 16 and 26 by 42-in. Wetherill-Corliss engines, direct connected to 300-k.w. General Electric generators. These supply current for power and lighting at 230 volts. For light loads a 12 by 11-in. Harrisburg standard engine, direct connected to a 50-k.w. General Electric dynamo, is provided. Compressed air at 80 lbs. pressure per sq. in. is furnished by two 11 and 20 and 18 and 11 by 24-in. Franklin air compressors. Hydraulic pressure at 525 lbs. per sq. in. for operating the elevators and for the wheel breakers and hot metal reservoirs is furnished by two Epping-Carpenter 8 and 12 and 20 and 4¾ by 16-in. pressure pumps in connection with two 20-in. by 10-ft. accumulators. The engine room is equipped with an Alfred Box & Company 12½-ton electric traveling crane, 42 ft. 4 ins. span.

The piping is very carefully designed and arranged to take care of almost any emergency. A 4-in. auxiliary header feeds the vacuum pumps and stoker engines, and in case of emergency can supply steam to part of the engine room equipment. The boiler feed pumps are supplied with steam from the drip line from the main steam headers. The system of drip piping is so arranged that each "T" in the main steam header is drained on its underside through a 1-in. nipple and valve into a 1½-in. drip line; this 1½-in. line has a uniform fall to the end of the power plant building, where the mixture of steam and water is deposited in a vertical drum, the lower end of which is drained by means of automatic traps provided in duplicate and by-passed, the water discharged from the traps being blown up into the heater and also arranged to be sent

to the sewer in case the heater should be closed down for repairs. From the top of the aforementioned drum the steam is conveyed to each of the boiler feed pumps, which are also supplied through branches from the auxiliary steam main, these latter branches, however, being normally shut off, so that all the steam supplied to the boiler feed pumps must be taken through the drip line. By this means a positive circulation of steam and water through the various drip connections is ensured, and at the same time the feed pumps are always supplied with steam during the operation of the plant.

Engine oil, cylinder oil and lubrolene for the air compressors are supplied from tanks in the boiler room 19 ft. above the engine room floor. The oil is returned to these tanks by 3 by 2 by 3-in. Worthington pumps, which may be driven by either steam or compressed air. There are four of these pumps, two for engine oil and one each for the cylinder oil and lubrolene. The tanks are closed, so that the pumps can force the oil by any obstructions. Overflow of the pumps indicates that the overhead tanks are full. The engine oil is filtered before being returned to the overhead tanks.

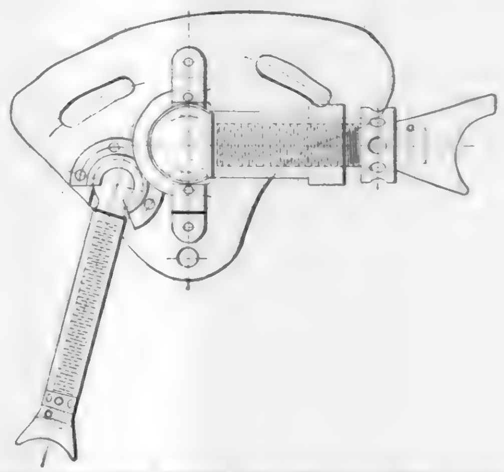
The piping and electric wires are carried from the power house through a concrete tunnel to the different buildings. The sizes of the pipes at the power house end of the tunnel are 4-in. air, 6-in. steam, 5-in. hydraulic, 6-in. hydraulic return, 20-in. exhaust and 6-in. drip.

GOOD WORK DONE ON OLD DRIVING WHEEL LATHES.

From time to time we have called attention to the splendid work being done by the latest designs of driving wheel lathes. The improvement in the design and operation of these lathes has been so rapid that the best ones which could be purchased four or five years ago are now spoken of as old machines. While recently visiting a shop which was equipped with the best driving wheel lathes on the market five years ago the shop superintendent passed them by with the remark: "These are old wheel lathes, and, of course, cannot be expected to do the work done by those of more recent design. We expect in the near future to replace two of them with one of the new ones."

This same shop superintendent frankly admitted, however, that, due to improved shop conditions, the use of high-speed steel, improved methods of handling the wheels in and out of the lathe, and a few changes in the design of the machines, they were at present turning out at least three times as much work as when they were first placed in service. An instance where splendid results were obtained after making a few changes in the design of an old lathe and the method of holding or clamping the wheels, was described on page 299 of our August issue.

The work being done on a 69-in. Niles driving wheel lathe, of comparatively light design, which has been in service at the East Moline shops of the Chicago, Rock Island & Pacific Railway about two and a half years, was recently called to our attention. The lathe is driven by a 15-h.p. variable speed motor. Holes have been cut through the face plates for the

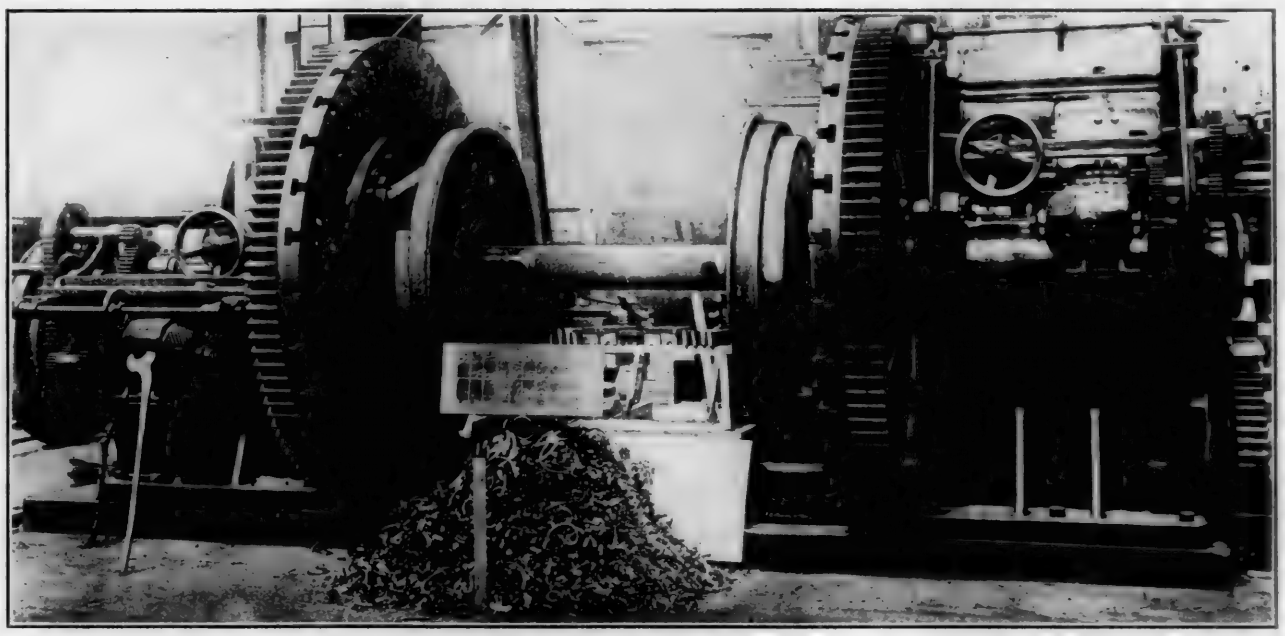


FOX AND WARE DRIVER FOR DRIVING WHEEL LATHE.

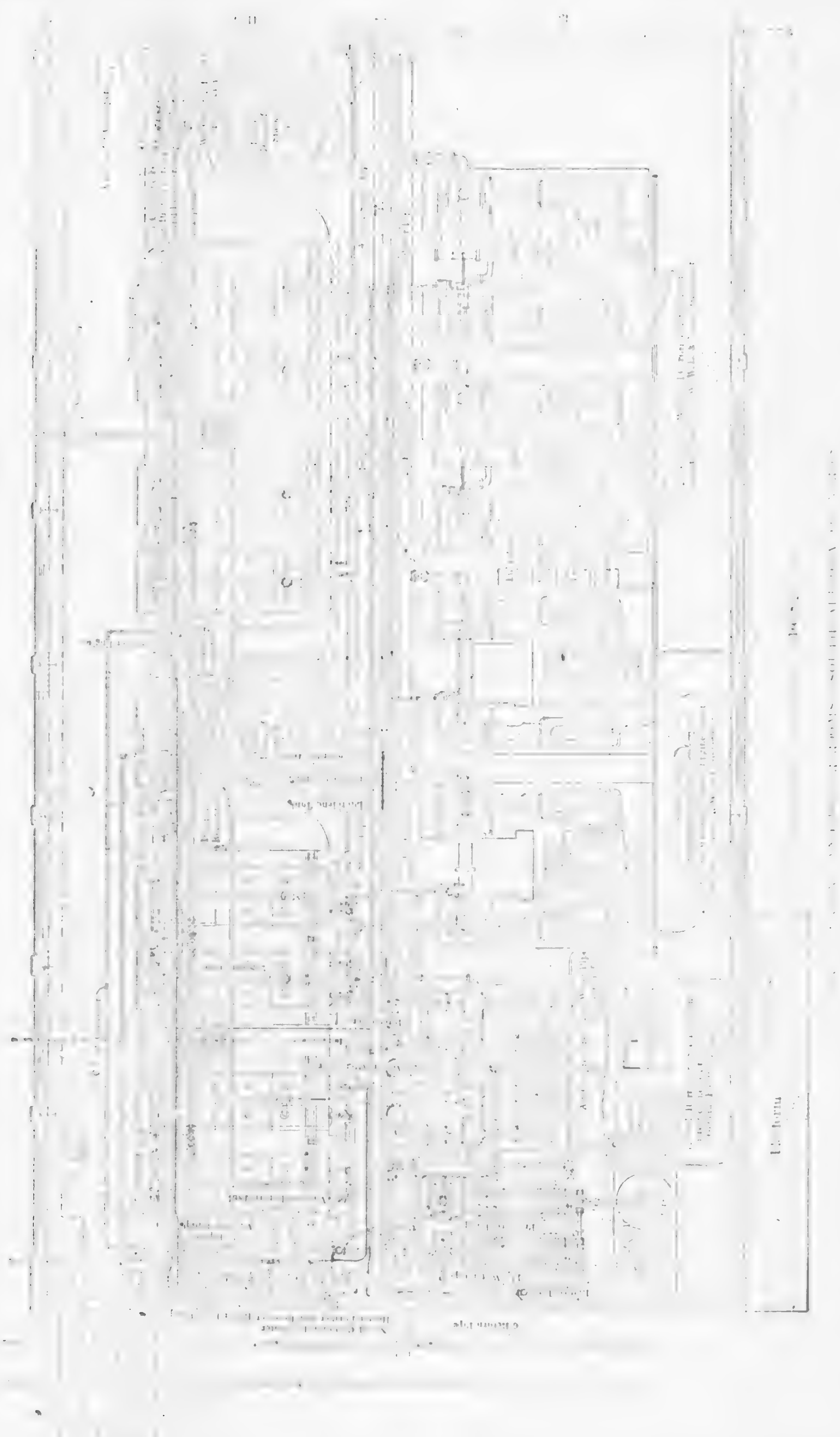
crank pins, and the traversing screw, which operates the rear head, has been changed from a 4 to a 1-in. pitch, double thread, in order to allow the head to be moved backward and forward more quickly. This latter change was made after the record run, noted below, was made

The lathe is also equipped with special drivers for holding the wheels, which are shown in the accompanying illustration, and which have been patented by Mr. E. O. Ware, machine shop foreman at East Moline, and Mr. F. E. Fox, master mechanic of the Rock Island at Cedar Rapids, Iowa. Two drivers are placed on each face plate, one of them having two adjustable arms, as shown in the illustration, while the other has only one. The forked end of the arm fits against the rim of the wheel at its junction with one of the spokes. The heavier arm on the double driver is adjusted to resist the stress due to cutting. The purpose of the lighter arm which grasps the wheel in the opposite direction is to hold it rigidly in place and prevent chattering.

In a test of this lathe 10 pairs of driving wheels were turned in 10 hrs. 19 min., 1,665 lbs. of metal being removed. The first four pairs were Standard steel, 48½ ins. in diam



90-INCH NILES DRIVING WHEEL LATHE, OMAHA SHOPS—UNION PACIFIC RAILROAD.



and is stored in a large continuous steel bin above the boilers, from which it is fed to the stokers. The conveying and coal-crushing apparatus is driven by two 10-h.p. motors installed in the boiler room basement. The ashes are conveyed to a bin above the coal delivery track, and are loaded from this directly into hopper cars. Two 3-in. motor-driven centrifugal pumps drain the water collected in sumps in the ash tunnel below the sewer level. The boilers are fed by three 12 by $7\frac{1}{2}$ by 10-in. Worthington boiler feed pumps. The feed water is heated by two No. 31 Cochrane 1,700-h.p. feed water heaters, purifiers and receivers. Two 8 by 14 by 16-in. vacuum pumps are used in connection with the Warren-Webster system of steam circulation.

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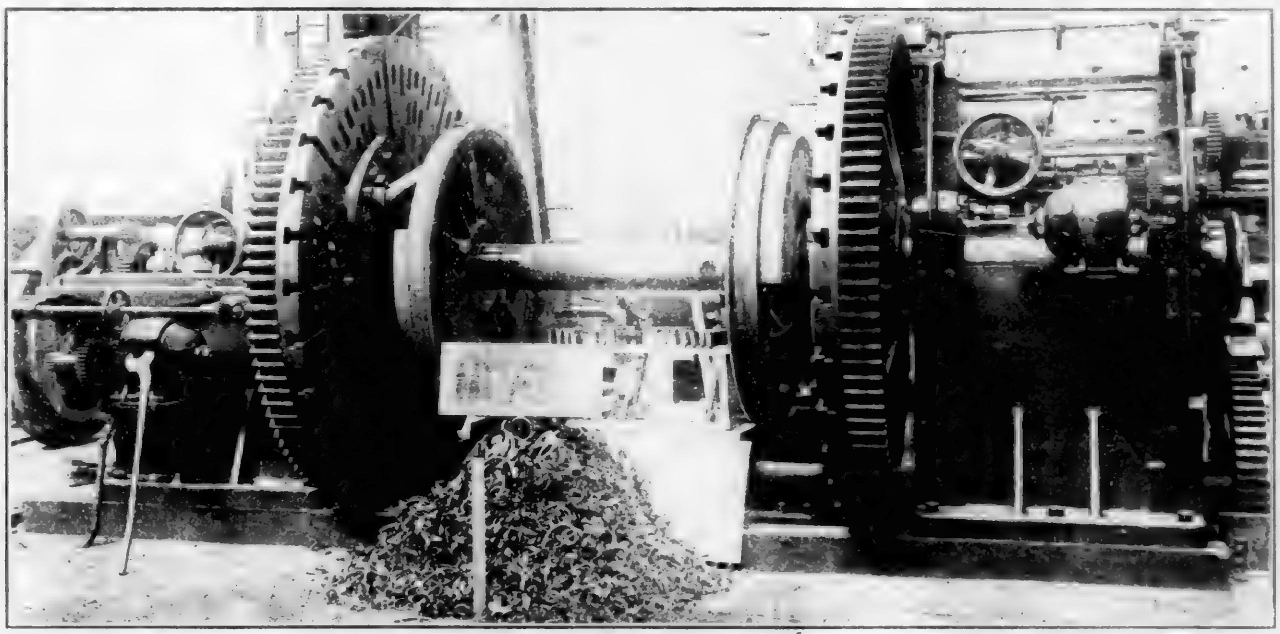

90-INCH NILES DRIVING WHEEL LATHE, OMAHA SHOPS—UNION PACIFIC RAILROAD.

eter. On two of these the feed used was ⅜ in., the depth of cut 5-16 in., and the cutting speed varied from 11 to 20 ft. per min. On the other two the feed used was ¼ in., the depth of cut 5-16 in., and the cutting speed varied from 13 to 16 ft. per min. The other six pairs of drivers were of Midvale steel, 58 ins. in diameter. On two pairs of these a feed of ¼ in. was used, depth of cut 5-16 in., and a cutting speed of from 14 to 18 ft. per min. On the other four the feed was ¼ in., depth of cut ¼ in., and cutting speed 14 to 18 ft. per min., although in one instance it ran as high as 20 ft. per min. From the detail report it would appear that the various tool steels which were used in the test were pretty badly punished.

Another test of an old driving wheel lathe, which has had several improvements made to it, recently took place in the Omaha shops of the Union Pacific Railroad Company. This is a Niles 90-in. lathe, driven by a 15-h.p. motor, and has been in service for the past four years. It is also equipped with the Fox and Ware drivers described above. Previous to the test the feed gear was redesigned to increase its capacity, the bearings were thoroughly examined and all slack taken up, holes were bored in the face plate to take the crank pins, and the movable face plate was equipped with a motor and chain drive.

TEST OF OLD 90-INCH DRIVING WHEEL LATHE—OMAHA SHOPS, UNION PACIFIC RAILROAD COMPANY.

Diam. of wheel centers. Ins.	Cutting speed, ft. per min.	Amt. of feed. Ins.	Depth of cut Ins.	Size of tool. Ins.	Time of cutting. Min.	Time chg. wheels. Min.	Amt. of metal remov. Lbs.	Total time. Min.
55	18	⅜	⅜	2½ x 1½	50	13	177	63
55	18	⅜	⅜	2½ x 1½	51	11	174	62
55	18	¼	½	2½ x 1½	56	12	188	68
50	15	⅜	⅜	2½ x 1½	57	11	178	68
50	15	⅜	⅜	2½ x 1½	50	7	182	57
50	15	⅜	5/16	3 x 1½	48	14	173	62
50	15	⅜	5/16	3 x 1½	55	10	188	65
50	15	⅜	⅜	3 x 1½	55	5	184	60
44	12	⅝	¼	2½ x 1½	30	5	169	35
44	12	⅝	¼	3 x 1½	35	5	175	40
44	12	⅝	¼	2½ x 1½	30	5	172	35

Total time, 10 hrs. 15 mins. Average time per pair, 55.9 mins. Total amount of metal removed, 1,960 lbs.

In a test made on June 14, details of which are presented in the accompanying table, 11 pairs of wheels were turned in 10 hrs. 15 min., 1,960 lbs. of metal being removed.

These tests certainly demonstrate that with a few changes in the design, and proper care and attention, the wheel lathe of four or five years ago can do much better work than is generally obtained from it in the larger percentage of shops in which it is installed. Its design is, of course, such that it cannot compete with the more recent designs as far as the size of the cut is concerned, as a comparison of these records with that of the New York Central lathe at West Albany, as recorded on page 74 of our February, 1906, issue, will show. By using higher cutting speeds, however, possibly at the expense of the tool steel, the records on the lighter machines are very favorable. Just how long the lighter lathes would stand up under this kind of treatment is, of course, a question, but where it was necessary to keep them working at this pace, or even a considerably slower one, for any length of time, it would probably make a great enough saving to enable the railroad company to scrap the machine with good grace. These results must, of course, be considered in the light of special tests or records, and not as of everyday occurrence. They do, however, indicate that much more may be obtained from the older designs than is ordinarily expected of them.

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In house, hot	2	5.2
Discovered arriving at terminal	2	5.2

It will be noted from the above that 71.7 per cent. occurred while the engine was being washed, this including 41 per cent where nozzles were being used at the time; 17.9 per cent. occurred while the engine was cold, under other circumstances, making a total of 89.6 per cent. for the failures while the engine was cold. This leaves 10.4 per cent. for failures while the engine was hot, but it is not improbable, if full details of the conditions attending the failures in these latter cases were at hand, that in some or perhaps all, the records would show the engine had been cold. When washing the boilers, cold water had probably been used in all cases, and the above figures would seem to argue very strongly in favor of keeping the boiler continuously hot, and the use of a method of washing where the boiler does not get cold, say not below 150 degrees F.

Erie Fixes an Age Limit.—Superintendent Sharpe, of the Susquehanna Division of the Erie, has issued a notice that hereafter persons seeking to enter the employ of the company in either the train, engine, station, signal or switching departments, or as telegraph operators, clerks or stenographers, must not be more than 35 years old. The same maximum age limit is announced for messengers, rivet heaters, mechanics and helpers, while apprentices must not be older than 21 years. Roundhouse men may apply up to 40 years of age, and stationary engineers, firemen and car-track repairers may be taken on up to 45. The highest age limit allowed is 50 years, and this applies only to outdoor laborers and freight handlers.—*Railway World.*

SIMPLE PACIFIC TYPE PASSENGER LOCOMOTIVE—NORFOLK & WESTERN RAILWAY.

PACIFIC TYPE PASSENGER LOCOMOTIVE.

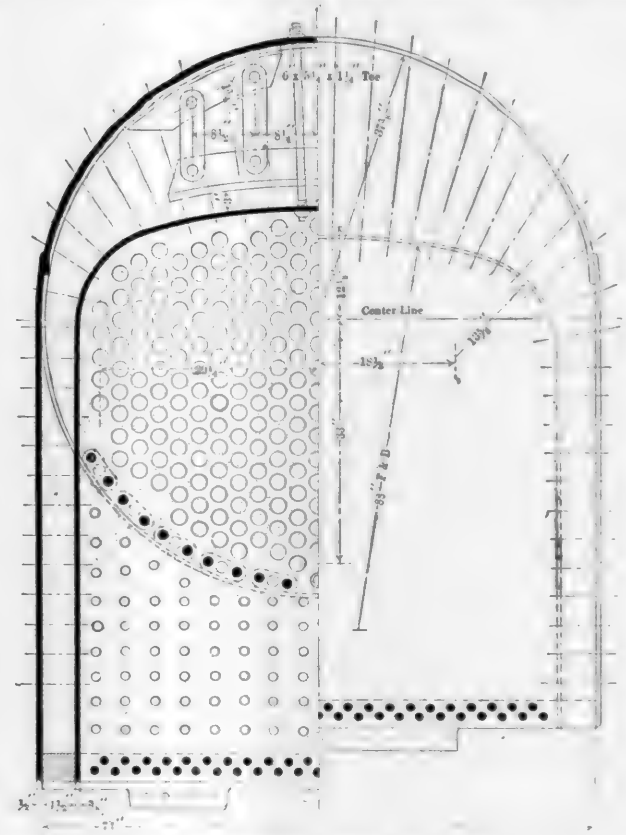
Norfolk & Western Railway.

The American Locomotive Company recently delivered from its Richmond shops an order of five Pacific type locomotives to the Norfolk & Western Railway, which form an example of the value of increased boiler capacity for handling heavy trains on a high schedule over difficult grades, as they replace engines of the same size cylinders and wheels but with smaller boilers.

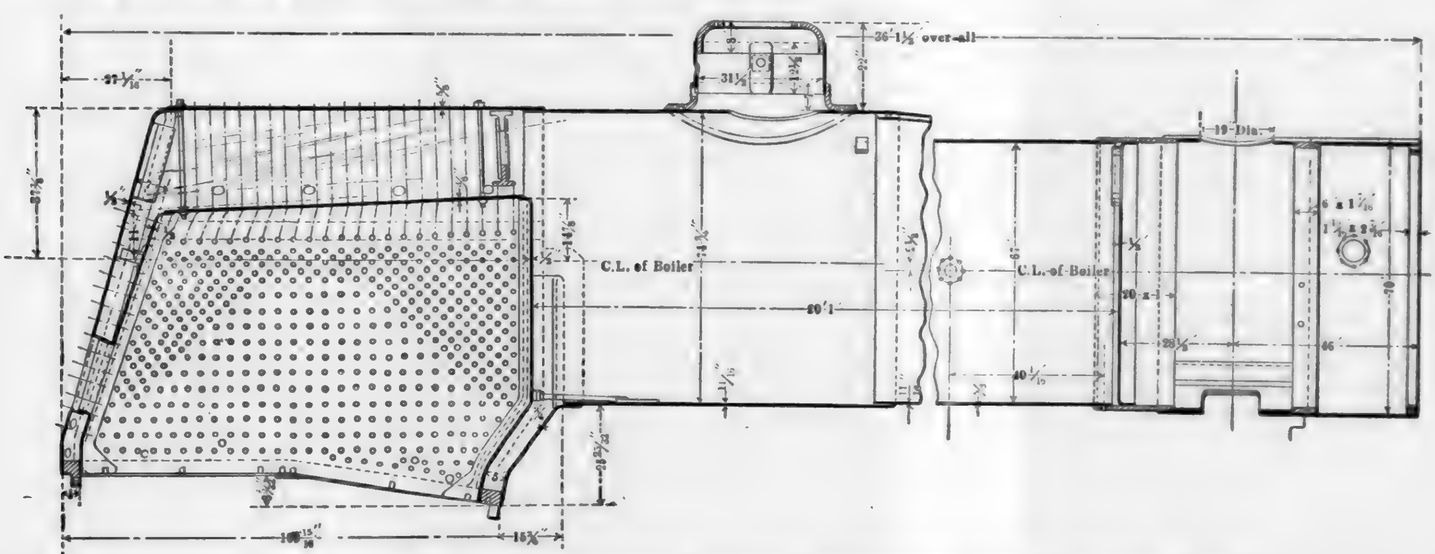
These locomotives are designed for a passenger run over the mountains from Roanoke, Va., to Bristol, Tenn. This train had previously been hauled by 10-wheel locomotives with 20 by 28-in. cylinders and 68-in. wheels, and with a somewhat greater weight on drivers than was given to the newer engines, but necessarily with a considerably smaller boiler. As far as tractive power was concerned the 10-wheel engines were satisfactory, but it was found that the boiler was not capable of supplying the cylinders under the difficult operating conditions met with. These new engines have been in service long enough to show that even with less weight on drivers they are capable of handling the train, even with extra cars, to much better advantage than the older engines, being able to make up considerable time on a difficult schedule.

As may be seen by reference to the table of dimensions these locomotives have 20 by 28-in. simple cylinders and 68-in. drivers, giving a tractive power of 28,000 lbs. The weight on drivers is 125,000 lbs., or 64 per cent. of the total weight of 195,250 lbs. The tractive ratio of 4.46 is within the limits of good adhesion.

The boiler, sections of which are given herewith, is 67 ins. in diameter at the front ring and 74¾ ins. at the dome course. It is of the extended wagon top type and contains 279—2¼-in. flues 20 ft. 1 in. long. The smokebox, which extends 46 ins. ahead of the centre of the cylinders, is connected to the boiler by a ring 20 ins. wide by 1 in. thick. The forward barrel sheet is fastened to the inside of this ring at one end and the smokebox to the outside of it at the other. The front tube sheet is fastened inside the ring just ahead of the connection to the boiler shell. This construction, while somewhat



HALF CROSS-SECTION AND END VIEW.



LONGITUDINAL SECTION OF BOILER—PACIFIC TYPE LOCOMOTIVE—NORFOLK & WESTERN RAILWAY.

eter. On two of these the feed used was 3/8 in., the depth of cut 5-16 in., and the cutting speed varied from 11 to 20 ft. per min. On the other two the feed used was 1/4 in., the depth of cut 5-16 in., and the cutting speed varied from 13 to 16 ft. per min. The other six pairs of drivers were of Midvale steel, 58 ins. in diameter. On two pairs of these a feed of 1/4 in. was used, depth of cut 5-16 in., and a cutting speed of from 14 to 18 ft. per min. On the other four the feed was 1/8 in., depth of cut 1/4 in., and cutting speed 14 to 18 ft. per min., although in one instance it ran as high as 20 ft. per min. From the detail report it would appear that the various tool steels which were used in the test were pretty badly punished.

Another test of an old driving wheel lathe, which has had several improvements made to it, recently took place in the Omaha shops of the Union Pacific Railroad Company. This is a Niles 90-in. lathe, driven by a 15-h.p. motor, and has been in service for the past four years. It is also equipped with the Fox and Ware drivers described above. Previous to the test the feed gear was redesigned to increase its capacity, the bearings were thoroughly examined and all slack taken up, holes were bored in the face plate to take the crank pins, and the movable face plate was equipped with a motor and chain drive.

TEST OF OLD 90-INCH DRIVING WHEEL LATHE—OMAHA SHOPS—UNION PACIFIC RAILROAD COMPANY.

Diam. of wheel center Ins.	Cutting speed, ft. per min.	Amt. of feed Ins.	Depth of cut Ins.	Size of tool In.	Time of cutting, Min.	Time chg. wheel Min.	Amt. of metal remov. Lbs.	Total time, Min.
55	18	3/8	3/8	2½ x 1½	50	13	177	63
55	18	3/8	3/8	2½ x 1½	51	11	174	62
55	18	1/4	1/2	2½ x 1½	56	12	188	68
50	15	3/8	3/8	2½ x 1½	57	11	178	68
50	15	3/8	3/8	2½ x 1½	50	7	182	57
50	15	3/8	5-16	3 x 1½	48	14	173	62
50	15	3/8	5-16	3 x 1½	55	10	188	65
50	15	3/8	1/4	3 x 1½	55	5	184	60
44	12	3/8	1/4	2½ x 1½	30	5	169	35
44	12	3/8	1/4	[illegible] x 1½	35	5	175	40
44	12	3/8	1/4	2½ x 1½	30	5	172	35

Total time, 10 hrs. 15 min. Average time per pair, [illegible]. Total amount of metal removed, 1,960 lbs.

In a test made on June 11, details of which are presented in the accompanying table, 11 pairs of wheels were turned in 10 hrs. 15 min., 1,960 lbs. of metal being removed.

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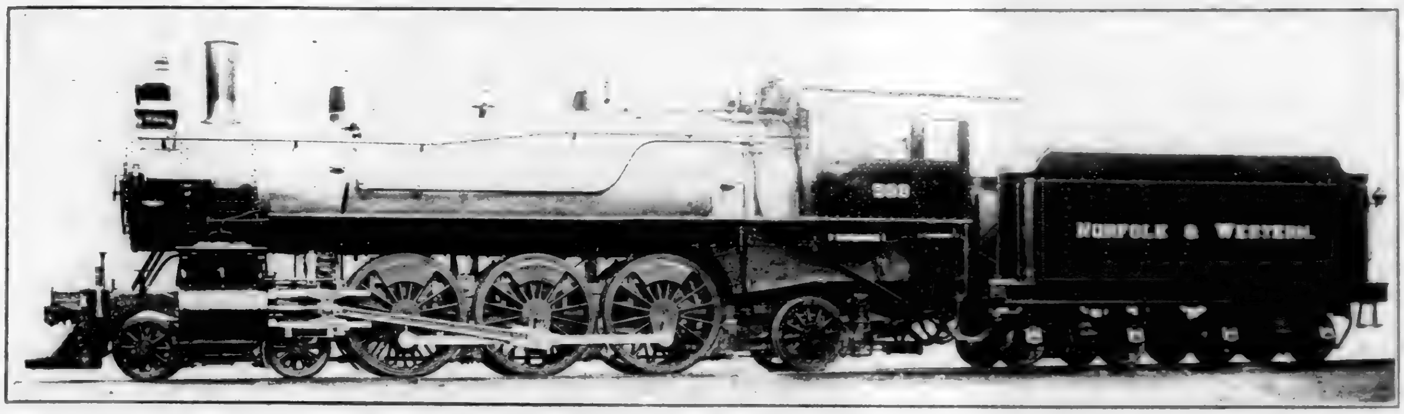

SIMPLE PACIFIC TYPE PASSENGER LOCOMOTIVE—NORFOLK & WESTERN RAILWAY.

PACIFIC TYPE PASSENGER LOCOMOTIVE.

NORFOLK & WESTERN RAILWAY.

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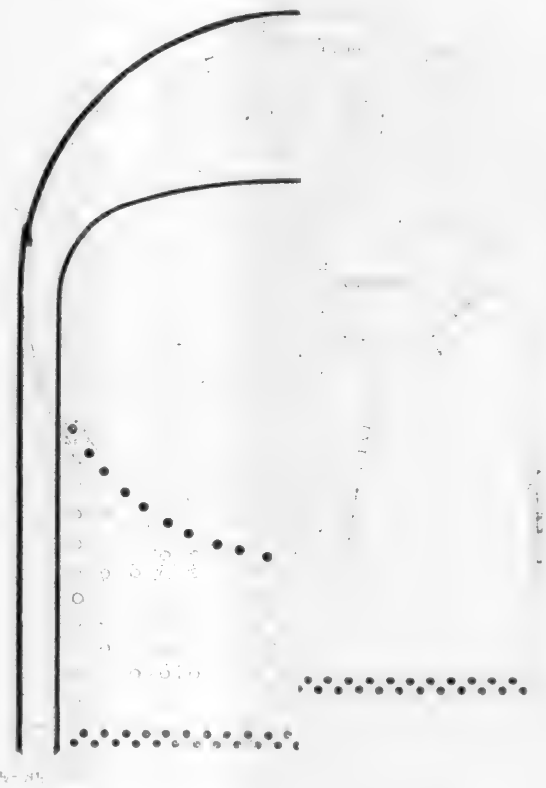
The boiler, sections of which are given herewith, is 67 ins. in diameter at the front ring and 74¾ ins. at the dome course. It is of the extended wagon top type and contains 279—2¼-in. flues 20 ft. 1 in. long. The smokebox, which extends 46 ins. ahead of the centre of the cylinders, is connected to the boiler by a ring 20 ins. wide by 1 in. thick. The forward barrel sheet is fastened to the inside of this ring at one end and the smokebox to the outside of it at the other. The front tube sheet is fastened inside the ring just ahead of the connection to the boiler shell. This construction, while somewhat



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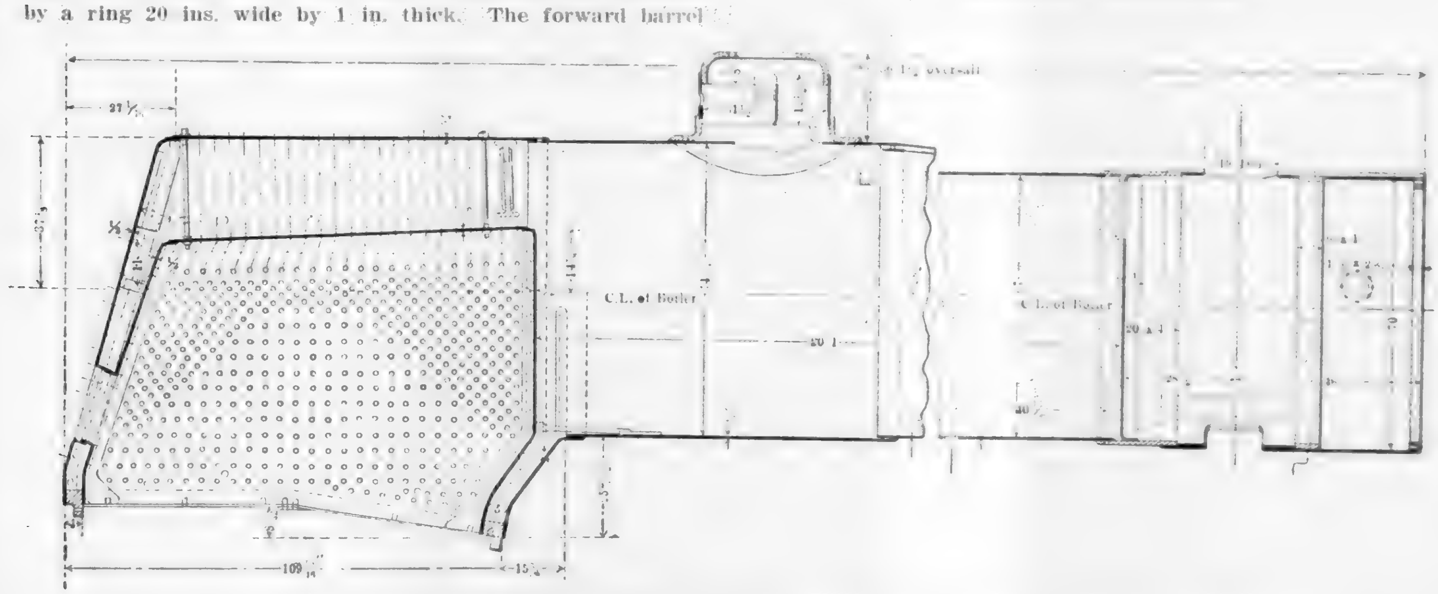
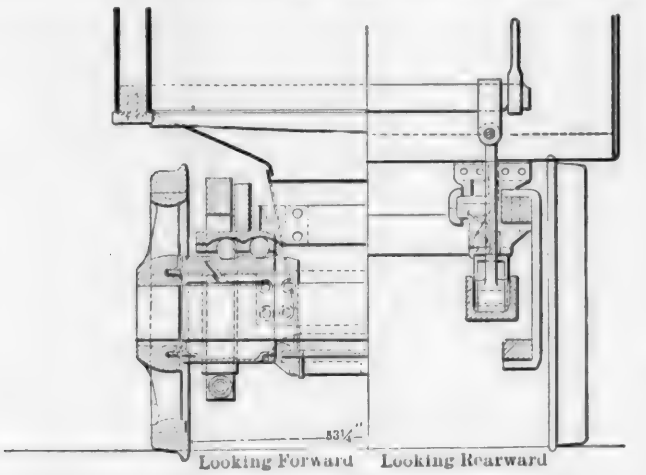


LONGITUDINAL SECTION OF BOILER—PACIFIC TYPE LOCOMOTIVE—NORFOLK & WESTERN RAILWAY.

unusual, has a number of points in its favor when considered with a view to boiler repairs. The firebox measures 64¼ by 100 ins. and gives a grate area of 45.5 sq. ft. The front mud ring is 5 ins. wide and the water space in the throat is about the same width all the way up. The outside and inside firebox sheets are vertical, extending up from the 4½-in. mud ring to the crown sheet without perceptible increase of water space.



SECTION NEAR TRAILER TRUCK—PACIFIC TYPE LOCOMOTIVE NORFOLK & WESTERN.

At the rear, however, the mud ring is 4 ins. wide and the water space is increased to 7 ins. at the crown sheet. The crown sheet has a slope of nearly 4 ins. toward the rear. It will be noticed that an unusually large number of staybolts have been placed along the top and upper corners of the side sheets. Former trouble with staybolt breakages led to the decision to double the number of bolts at the points where the most trouble occurred.

This boiler gives a total heating surface of 3,463.7, of which 3,286.2 sq. ft. is in the tubes and 177.5 in the firebox. This amount of heating surface is unusually large for an engine having cylinders of this size and gives 340 sq. ft. of surface per cubic foot of cylinder volume, a figure considerably in excess of most simple passenger locomotives, but one which has proven itself to be most useful in service. The B. D. ratio (tractive effort × diameter of drivers ÷ heating surface) of 550 also indicates very clearly that these engines have an ample boiler capacity for high speed work; however, in this consideration it should be remembered that a very large proportion of this heating surface is in the flues, there being less than 5¼ per cent. of the total in the firebox, the remainder being in flues of a length equal to 107 diameters.

The trailing truck construction here employed is of interest. The frames are continuous and hence inside the trailing wheels. The trailing journal boxes are of special design and extend some distance inside of the frames, and have two slight depressions with chilled surfaces on the top in which rest two steel rollers. On top of the rollers is a casting having similar depressions for bearing surfaces, and above this, just inside the frame, is an equalizer which fastens through links to one end of an elliptical spring at the rear and to an equalizing bar in front. The upper bearing plates are connected together across the engine, thus being held stationary in the horizontal plane. The equalizing bar connecting the spring from the rear drivers and the equalizer over the trailing truck is necessarily inside the plane of the frame and is U shape in section. Its centre bearing is taken through a semi-elliptical spring which rests upon a frame-stiffening casting extending between the frames. This casting also forms the firebox support at this point. This construction, together with the connections and the spring rigging to the rear drivers, is shown in one of the illustrations herewith.

The front truck is of the three-point suspension type and will be illustrated separately in a later number. The general dimensions, weights and ratios are as follows:

SIMPLE PACIFIC TYPE PASSENGER LOCOMOTIVE, NORFOLK & WESTERN RAILWAY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Bit. Coal
Tractive power	28,000 lbs.
Weight in working order	195,250 lbs.
Weight on drivers	125,000 lbs.
Weight of engine and terder in working order	305,150 lbs.
Wheel base, driving	12 ft.
Wheel base, total	30 ft. 6½ in.
Wheel base, engine and tender	54 ft. 11 15-16 ins.

RATIOS.

Weight on drivers ÷ tractive effort	4.46
Total weight ÷ tractive effort	6.98
Tractive effort x diam. drivers ÷ heating surface	550
Total heating surface ÷ grate area	76.
Tube heating surface ÷ firebox heating surface	18.5
Weight on drivers ÷ total heating surface	36.2
Total weight ÷ total heating surface	56.3
Volume both cylinders	10.2 cu. ft.
Total heating surface ÷ vol. cylinders	340
Grate area ÷ vol. cylinders	4.47

CYLINDERS.

Kind	Simple
Diameter and stroke	20 x 28 ins

VALVES.

Kind	Piston
Greatest travel	6¼ ins.
Outside lap	1⅛ ins.
Inside clearance	0 in.

WHEELS.

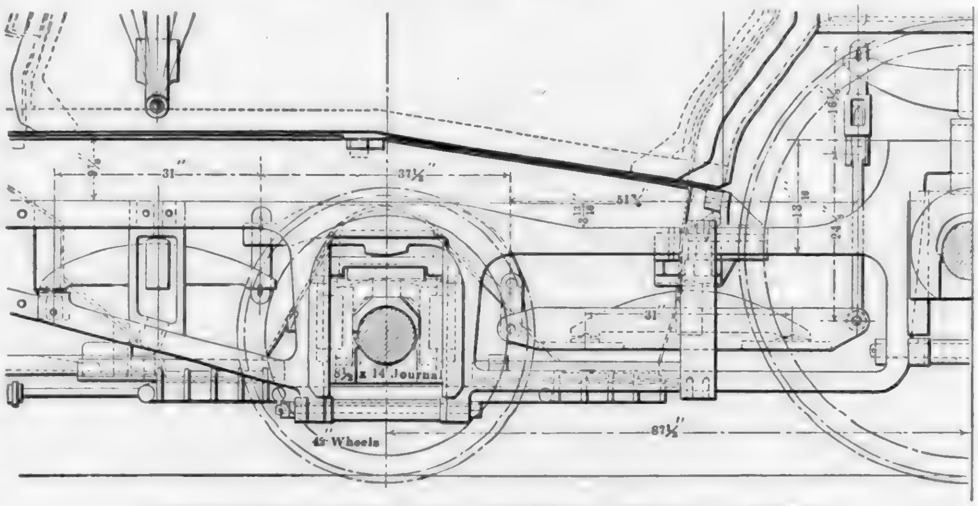
Driving, diameter over tires	68 ins.
Driving, thickness of tires	3 ins.
Driving journals, main, diameter and length	8½ x 10½ ins.
Driving journals, others, diameter and length	8½ x 10½ ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	5½ x 10 ins.
Trailing truck wheels, diameter	42 ins.
Trailing truck, journals	8½ x 14 ins.

BOILER.

Style	Ext. Wagon Top
Working pressure	200 lbs.
Outside diameter of first ring	67 ins.
Firebox, length and width	99 15-16 x 64¼ ins.
Firebox, plates, thickness	⅜ & ½ in.
Firebox, water space	4-4½-5 ins.
Tubes, number and outside diameter	279-2¼ in.
Tubes, length	20 ft. 1 in.
Heating surface, tubes	3286.2 sq. ft.
Heating surface, firebox	177.5 sq. ft.
Heating surface, total	3463.7 sq. ft.
Grate area	45.5 sq. ft.
Smokestack, diameter	15 ins.
Smokestack, height above rail	15 ft. 3⅜ ins.

TENDER.

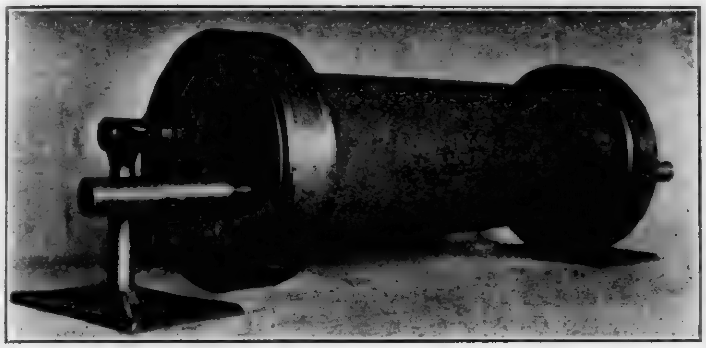
Tank	"U" shape.
Frame	Channels
Wheels, diameter	33 ins.
Journals, diameter and length	5¼ x 9 ins.
Water capacity	6,000 gals.
Coal capacity	10 tons.



TRAILER TRUCK—PACIFIC TYPE LOCOMOTIVE—NORFOLK & WESTERN

A SUCCESSFUL PISTON VALVE.

The following data which we have received concerning tests of the American Semi-plug piston valve speaks for itself. In June, 1901, Mr. C. R. Williams, general master mechanic of the Buffalo & Susquehanna Railroad Company, equipped a consolidation locomotive with these valves. After being in service for two years and ten months, during which time the engine ran 91,341 miles, the valves were removed for exhibition at the Louisiana Purchase Exposition, and were found to be in good condition with the cages or bushings worn perfectly true.



SEMI-PLUG PISTON VALVE AFTER RUNNING OVER STEAM PORTS WITHOUT BRIDGES ONE YEAR ON N. Y. C. & H. R. R. R.

It was found impossible to remove the bushings without destroying them, and they were equipped with a new set of valves. During July of this year, or five years after the bushings had been placed in service, the engine was placed in the shop for repairs and the bushings were found to be still steam tight, and to all appearances the same as when first applied. This is indeed a remarkable result, especially in view of the fact that the profile of the division upon which the engine was operated is such as to necessitate a considerable amount of drifting. No relief or by-pass valves were used in connection with the piston valves, and the engine when drifting was operated the same as if equipped with slide valves.

An examination of the construction and operation of the valves shows why these remarkable results were obtained. The inner sides of the snap-ring, shown in the illustration of the valve, are beveled, while the outer sides fit against the straight walls of the spool. The wall rings are solid and nonexpansible and the inner sides are beveled to a much sharper angle than the outer sides, which are in contact with the snap-rings. The snap wedge ring between the two wall rings is put in under tension, thus holding the wall rings apart and applying a slight lateral pressure on the snap-rings. In this condition the snap-rings are expanded against the casing, just

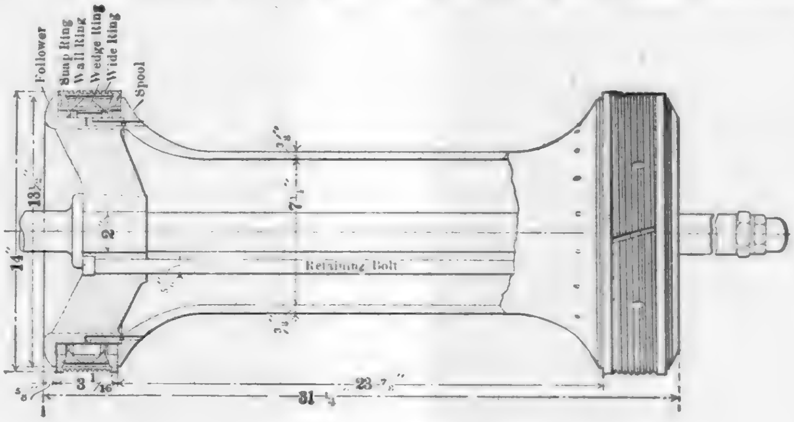
DOUBLE END SEMI-PLUG PISTON VALVE FOR COMPOUND ENGINE.

enough to make a steam tight joint. When steam is admitted to the valve it enters underneath the wedge ring, forcing it outward, and thus exerting a greater lateral pressure on the snap-rings and locking them in position. The function of the wide ring, which is between the snap rings and interlocked with them, is to keep them parallel when the wedge ring is collapsed, as in drifting. It also compels the snap-rings to expand and contract together, thus supplying a means of passing over the steam ports when the engine is drifting without allowing the snap-rings to spring into the ports.

The valve is thus in effect a plug valve with an automatic adjusting snap-ring operating with a minimum amount of friction. This latter feature is important when we consider that the ordinary type of piston valve is unbalanced, and a considerable amount of power is required to overcome the excessive friction caused by the pressure of the rings against the walls of the valve chamber.

To demonstrate that the contact of the rings with the bushing is absolutely controlled, a set of valves were applied to an engine on the Pennsylvania Division of the New York Central & Hudson River Railroad under Mr. E. A. Walton, division superintendent of motive power, on July 1, 1905. The bridges in the steam ports were removed. After a year's service, with the valves passing over the ports without bridges, there was no sign of a blow and no perceptible wear of either the valve bushings or rings.

The committee on piston valves in their report to the Master Mechanics' Association in 1904 cited a number of careful tests which were made by the Norfolk & Western Railway and the Lake Shore & Michigan Southern Railway to determine the amount of leakage of valves. The best piston valve showed a leakage of 268.56 lbs. per hour and the best slide valve a leakage of 348 lbs. per hour. The worst case of leakage of piston



SEMI-PLUG PISTON VALVE.

valves amounted to 2,880 lbs. per hour and of slide valves to 2,610 lbs. per hour.

The leakage of the Semi-plug piston valve, as indicated by the service results, is very slight, if any, and this considerable saving in addition to the saving of power, due to its being perfectly balanced, should materially aid in increasing the capacity of our motive power, which as far as size and weight are concerned, has apparently about reached the limit for operation under existing conditions. These valves, manufactured by the American Balance Valve Co., Jersey Shore, Pa., in addition to being made with the single end for simple engines, are also made with double and triple ends for compound engines.

NEW PENNSYLVANIA STEEL COACH.—The Pennsylvania Railroad has designed and built at Altoona a steel coach which weighs 103,550 lbs., as compared to 84,900 lbs. for the standard wooden coach. The extra weight is to some extent caused by the storage batteries for electric lighting and the heavy fireproof floor. The car has been placed on a local run and is being carefully tested. It is understood that the Pennsylvania intends to build a large number of steel cars for use in the New York tunnel, and that it has also requested the Pullman Company to make designs for sleeping cars of steel construction to be used on the Pennsylvania Lines.

STRANG GASOLINE-ELECTRIC MOTOR CAR—SANTA FE TRAIL ROUTE.

THE STRANG GASOLINE ELECTRIC MOTOR CAR.

The Strang gasoline electric motor car, "Ogerita," described on page 103 of our March issue, was placed in service in April on the Missouri & Kansas Interurban Railway, which is known as the Santa Fe Trail Route, and runs between Kansas City and Olathe, Kan., a distance of 22 miles. At the present time the car is being operated between Kansas City and Lenexa, a distance of 15 miles. It is making four round trips daily, hauling one or two trail cars, and has never missed a trip from any cause whatever since being placed in regular service. In order to hasten the completion of the line, the "Ogerita" was used as a freight engine, in some cases hauling as many as six freight cars from the main line of the Frisco Railroad to the tracks of the Santa Fe Trail Route.

Two new cars, the "Marguerite" and "Geraldine," equipped with the Strang system, have just been built for the Santa Fe Trail Route by the J. G. Brill Company, of Philadelphia. The "Marguerite," a combination passenger and smoker, shown in the illustration, measures 52 ft. 9 ins. over the ends, and the length of the passenger, smoking and engine compartments is respectively 27 ft. 5 ins., 10 ft. 8 ins., and 14 ft. 8 ins. The engine is a 4-cylinder, vertical type with 10 by 10-in. cylinders and, being equipped with an automatic regulating apparatus, requires no attention while running.

The first car, the "Ogerita," has traveled 18,000 miles, and the only repairs necessary have been those due to the renewing of brake shoes, etc. This car went from Philadelphia to Kansas City in February over the Pennsylvania, West Shore, Lake Shore, Alton, and Rock Island Railroads, stopping at the principal points for inspection by railway officials. The average speed for the greater part of this distance was about forty-five miles an hour. Snow storms and the necessity at times of running behind freight trains reduced the average speed for the entire distance to about thirty-three miles per hour. The trip was made without any mishaps, and the engine was in first-class condition upon arrival at Kansas City. A trip was then made over the Santa Fe from Kansas City to Topeka and return. A heavy snow storm, with heavy drifts, was encountered on the return trip, but the car made the trip on schedule time, although regular trains were delayed by the storm. The Santa Fe officials then arranged a trip through southern Kansas from Kansas City to Independence and over a branch line of that system known as the Burlington branch. The round trip of 550 miles was made at an average speed of forty miles per hour. The Burlington Branch has grades as high as 3½ per cent. and curves as sharp as 16 degs. No difficulty was found in stopping and starting the car on a 3½ per cent. grade, and the average speed on the round trip of 118 miles over this branch was twenty-seven miles per hour.

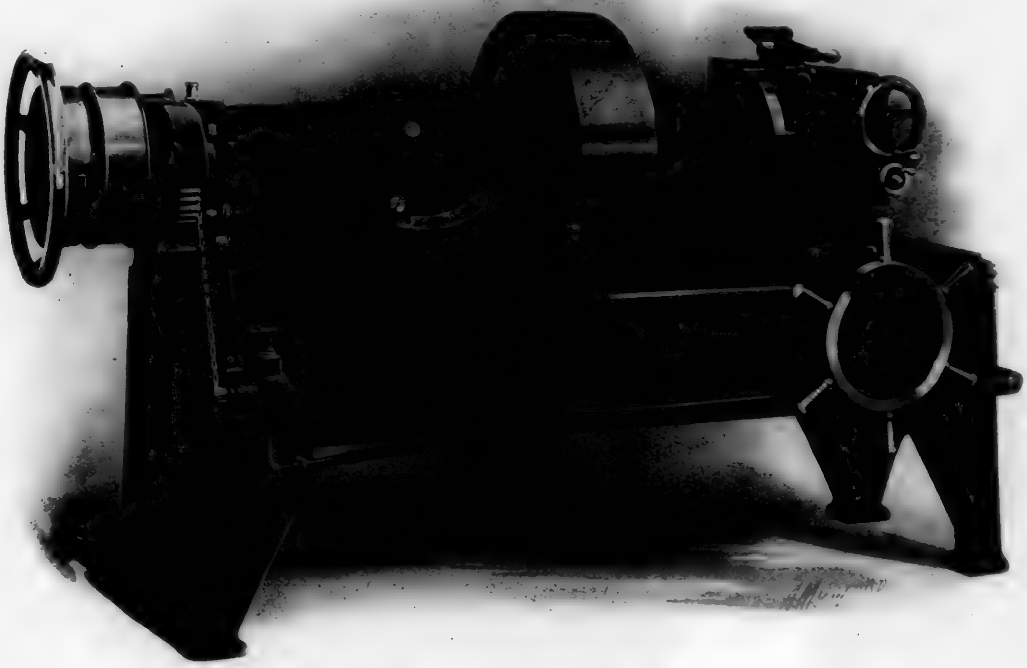
The total number of passengers carried in the New York Subway during April, May and June of this year was 37,161,607, as compared to 26,942,295 for the previous year. The car mileage was 8,656,535, as compared to 7,695,122.

CAST IRON CAR WHEELS SHOULD BE MORE ELASTIC.—That the cast iron car wheel can be made stronger and more durable by making it more elastic is a theory that is gaining ground. The present form of double plate wheel is extremely rigid, and contains metal where it is least needed. By reducing the rigidity of the portion between the rim and the hub the wheel will be made more flexible and better able to withstand shocks. In this way the flange, which is now the weakest part, and which cannot be enlarged because of the limitations imposed by frogs and crossings, will be relatively strengthened.—*The Iron Age.*

THE TURBINE STEAMSHIP LUSITANIA.—The largest horsepower afloat up to the present does not much exceed half that of the "Lusitania," which latter, at a minimum, will be 65,000. Since the ship has four separate propellers, each of these will have to absorb, say 16,500 h.p. The steam consumption of the "Lusitania" turbines may probably be taken fairly at 15 lbs. per h.p. per hour. This gives for 65,000 h.p. no less than 435 tons of steam per hour, and probably not much less than 50 tons of coal in the same period, or, say 1,200 tons per day of 24 hours. It is not remarkable that the engine and boiler room crews number 400 men.—*Cassier's Magazine.*

PROPER SALARY FOR PROPER MEN.—In this connection I would suggest that one of the best factors to improve and strengthen the position of engine house or terminal foreman is to give it the recognition and standing that it requires, on account of its importance in the mechanical department, and its far-reaching effects to other departments; that the salary paid this class of service be sufficiently high and remunerative to attract and obtain the proper class of men, who are competent and fitted to care for the work successfully and give it the proper kind of supervision, to obtain the best results expeditiously and economically, and take care of the various duties which come up every day, in such a way that the service is benefited and improved.—*Mr. E. T. James, New York Railroad Club.*

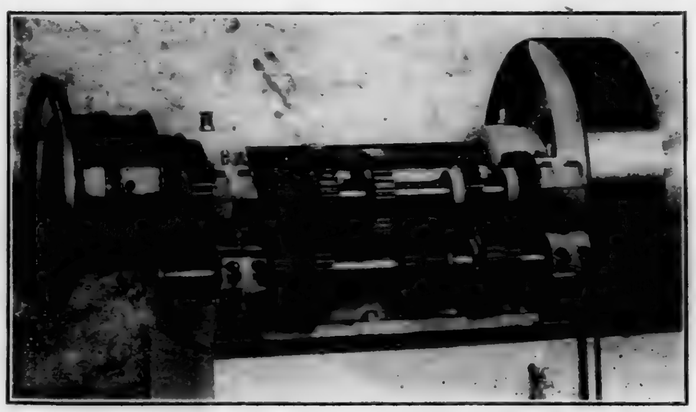
AN EXPOSITION OF SAFETY DEVICES.—The American Institute of Social Service will hold in New York City, in January next, an exposition of devices for safeguarding the lives and limbs of working men and women, and for preventing accidents under the ordinary conditions of life and labor to which the general public is exposed. The interest of manufacturers generally is solicited, as well as that of organizations whose special function is to improve the conditions of labor, and a widespread response is looked for to this request for representation in the nature of photographs, descriptive drawings, models, and, as far as possible, the devices themselves in actual operation. Requests for information regarding space should be made to Dr. William H. Tolman, Director, 287 Fourth Avenue, New York.



FOUR-INCH PIPE MACHINE—STOEVER FOUNDRY & MFG. COMPANY.

FOUR-INCH PIPE MACHINE.

The 4-in. pipe machine, illustrated herewith, is of very substantial construction, carefully designed to withstand the most severe strains, and may be quickly and conveniently operated. It has a capacity for from 1 to 4-in. pipe. The head stock is made in one casting. Twelve spindle speeds are obtained by means of the gear box. Four changes of speed are furnished by the handle on the side of the box, which throws different sets of gears into mesh, and three runs of gearing are obtained by means of a sliding key operated by the handle or knob at the left of the gear box. The gears are protected by guards. A speed plate on the gear box, conveniently placed for the operator, indicates how to obtain the proper speed for different sizes of pipe. The reverse movement for cutting left-hand threads may be obtained by means of a crossed belt on the countershaft. If desired, a motor drive may be used, a 1½-h.p. constant-speed motor being placed



ARRANGEMENT OF GEARING ON PIPE MACHINE.

above the head stock and connected to the driving shaft by Morse silent chain. A variable speed motor is not required, as sufficient speeds are provided by the gear box.

The gripping chuck is universal and grips the pipe at three points. The chuck may be operated from any one of three points on the circumference by a socket wrench. A centering chuck is placed on the rear of the spindle. It is a scroll chuck with three jaws and is easily operated by the large hand wheel on the outside of the shell.

The adjustable mechanism for setting the chasers is very simple. As the lever which operates it comes to rest on the screw, the straight-line feature is secured, and no digging into the pipe before releasing is possible. The cams are of steel, hardened and inserted in the cam ring. They are interchangeable and, if necessary, may be replaced at a small cost. In the die head the bottoms of the slots in which the chasers travel are formed of hardened steel plates, which keep the lead of the chasers true. The chasers are made of single pieces of steel, without links or pins. They are made one at a time by a special process, and any single chaser in the set may be replaced. They are inserted and removed through the center of the head. Oil is delivered to the dies and cutting-off tool by a pump driven by a chain, as shown. The pump operates with the machine running in either direction. The weight of this machine, which is made by the Stoever Foundry & Manufacturing Company of Myerstown, Pa., is 2,800 lbs.

COMPARATIVE TESTS OF ALCOHOL AND GASOLINE.—Tests recently made in internal combustion engines indicate a very high operating economy from alcohol, though it has only about 70 per cent. of the thermal value of gasoline. The superior economy with alcohol, which has been put as high as 20 per cent., is due in part to the higher pre-ignition compression. This showing is of considerable importance, in view of the removal next year of the internal revenue tax on denatured alcohol, which will, it is said, permit the commercial product to be sold for about the present price of gasoline. It is generally considered that alcohol may be used in standard gasoline engines with some slight modifications in the carbureter or vaporizing devices.—*Engineering Record.*

BRIQUETTES AS LOCOMOTIVE FUEL.—Consul James C. McNally, writing from Leige, says that it is interesting to note the continued increase in the use of briquettes which were introduced on the Belgian State Railways in 1898. For that year the consumption was 208 tons; in 1899, 3,900 tons; 1900, 20,472 tons; 1901, 67,775 tons; 1902, 110,600 tons; 1903, 152,219 tons, and in 1904, 205,175 tons.—*Ideal Power.*

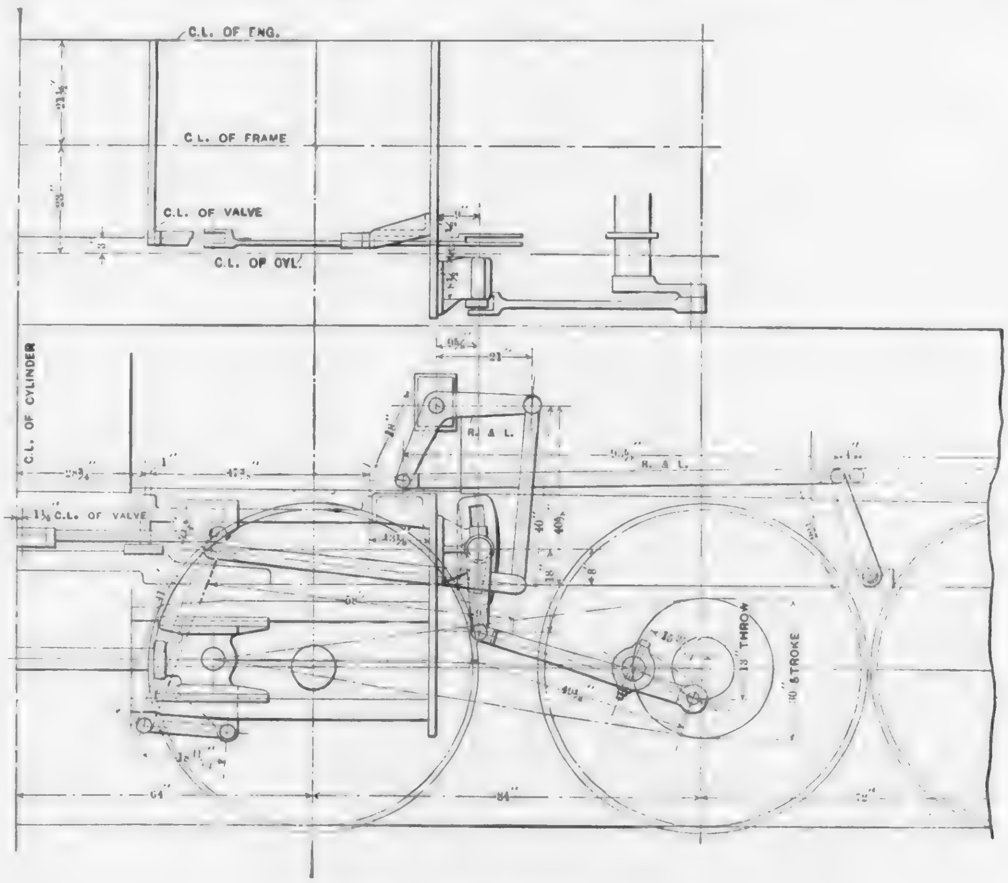
PRAIRIE TYPE LOCOMOTIVE, WITH WALSCHAERT VALVE GEAR—GREAT NORTHERN RAILWAY.

SIMPLE PRAIRIE TYPE LOCOMOTIVE WITH WALSCHAERT VALVE GEAR.

GREAT NORTHERN RAILWAY.

The Baldwin Locomotive Works has recently delivered an order of 50 Prairie type locomotives to the Great Northern Railway, which are illustrated herewith. These engines are, as regards size and capacity, almost identical with locomotives of similar type in use on the Chicago, Burlington & Quincy Railway, which were illustrated in the AMERICAN ENGINEER AND RAILROAD JOURNAL, September, 1904, page 356. The Great Northern engines, however, have cylinders 22 by 30, or 2 ins. longer than those used on the Burlington, which gives them a larger tractive force. They also have balanced slide valves and Walschaert valve gear instead of piston valves with Stephenson valve gear. Another difference noticeable in the two designs is the fact that the trailing wheels have inside bearings and that a Belpaire firebox has been used on the Great Northern engines.

A design of Walschaert valve gear is used on these engines which has been given careful study to make it as simple and convenient for repairs as possible. It will be seen, by reference to the illustrations, that the link is carried on a trunnion, which rests in bearings fastened to the back of the guide yoke, and receives its motion from the eccentric rod through an arm on the outer end of the trunnion. The whole gear has been thrown inward to an extent which permits the combination lever to extend down inside the guides, and thus throws the center of the valve 3 ins. inside the center of the cylinder. The details of this gear are clearly shown in the illustration.



APPLICATION OF WALSCHAERT VALVE GEAR.

Other interesting features in this engine are the use of a very short balanced slide valve set high above the cylinder, thus giving long steam ports; the location of the headlight on the front end door and the placing of the injectors on the back head and connecting them through external pipes to check valves at the usual location. The general dimensions, weights and ratios are as follows:

SIMPLE PRAIRIE TYPE FREIGHT LOCOMOTIVE—GREAT NORTHERN RAILWAY.

GENERAL DATA.

Gauge	4 ft. 8½ ins
Service	Freight
Fuel	Bit. coal
Tractive power	37,560 lbs.
Weight in working order, est.	209,000 lbs.
Weight on drivers, est.	151,000 lbs.
Weight on leading truck, est.	21,000 lbs
Weight on trailing truck, est.	37,000 lbs.
Weight of engine and tender in working order, est.	360,000 lbs
Wheel base, driving	13 ft
Wheel base, total	30 ft. 9ins.
Wheel base, engine and tender	63 ft. 8 ins.

RATIOS.

Weight on drivers ÷ tractive effort	4.02
Total weight ÷ tractive effort	5.56
Tractive effort x diam. drivers ÷ heating surface	746
Total heating surface ÷ grate area	65
Firebox heating surface ÷ tube heating surface	63 90
Weight on drivers ÷ total heating surface	43.5
Total weight ÷ total heating surface	60
Volume both cylinders	13.2 cu. ft.
Total heating surface ÷ vol. cylinders	263
Grate area ÷ vol. cylinders	4.04

CYLINDERS.

Kind	Simple.
Diameter and stroke	22 x 30
Valves	Bal. Slide

WHEELS.

Driving, diameter over tires	69 ins.
Driving, thickness of tires	3¼ ins.
Driving journals, main, diameter and length	9½ x 12 ins.
Engine truck wheels, diameter	36 ins.
Engine truck, journals	6 x 12 ins.
Trailing truck wheels, diameter	45 ins.
Trailing truck, journals	8 x 12 ins.

BOILER.

Style	Belpaire
Working pressure	210 lbs.
Outside diameter of first ring	72 ins.
Firebox, length and width	116 x 66 ins.
Firebox plates, thickness	⅜ & ½ in.
Firebox, water space	5 ins.
Tubes, number and outside diameter	301-2¼ in.
Tubes, length	18 ft. 6 in.
Heating surface, tubes	3,265 sq. ft.
Heating surface, firebox	206 sq. ft.
Heating surface, total	3,471 sq. ft.
Grate area	53.4 sq. ft.

TENDER.

Water capacity	8,000 gals.
Coal capacity	12 tons.

COMPARATIVE TEST OF SIMPLE AND COMPOUND LOCOMOTIVES.

The general results of a series of tests on two 10-wheel freight locomotives, one a simple and one a four-cylinder Vauclain compound engine, were given in a paper presented at the April meeting of the Western Railway Club by Mr. J. F. De Voy, mechanical engineer, Chicago, Milwaukee & St. Paul Railway.

	Simple			Compound.		
Number of run	1	2	3	1	2	3
Tonnage	982	1,140	1,152	1,074	1,106	1,050
Speed M. P. H.	28.2	23.56	29.1	26.5	20	28.5
Average draw bar pull	11,400	10,720	7,640	9,730	11,860	10,000
Average D. H. P.	972	711.8	633	702	675	821
Average I. H. P.	1,068	779	775	813	753	902
B. T. U. per D. H. P. Hour	46,554	52,861	65,002	51,933	47,578	47,511
Dry coal per sq. ft. grate per hr. lbs.	108.1	89.7	99.2	85	75.3	91
Water evaporated from 212° per sq. ft. H. S. per hr. lbs.	8.14	7.08	7.16	7.15	6.36	7.38
Water evaporated from 212° per lb. dry coal fired	6.02	6.44	5.84	6.75	6.76	6.49
Boiler efficiency	50.6%	53.1%	48.4%	55.7%	56.1%	54.1%
Steam per I. H. P. per hr. lbs.	21.43	25.7	26	24	23.5	22.92
Engine efficiency	9.975%	8.825%	7.75%	9.17%	10.3%	9.73%
Locomotive efficiency	4.8%	4.27%	3.64%	4.74%	5.04%	4.96%

The two locomotives had the following general dimensions:

	Simple.	Compound.
Weight on drivers	141,080 lbs.	135,555 lbs.
Cylinder diam. and stroke	21 x 30 ins.	15 & 25 x 30 ins.
Diameter of drivers	69 ins.	68 ins.
Steam pressure	200 lbs.	200 lbs.
Tube heating surface	2,748 sq. ft.	2,748 sq. ft.
Firebox heating surface	218 sq. ft.	198 sq. ft.
Total heating surface	2,966 sq. ft.	2,946 sq. ft.
Grate area	34.16 sq ft.	35 sq. ft.

Three regular test runs besides a preliminary run were made on each engine over a 125-mile division, with loads and results as shown in the above table.

In commenting on the results Mr. De Voy says: "The dry steam per dynamometer horse power is shown to be slightly less for the compound, with the exception of run No. 1 of simple engine. This is explained by the fact that on this run the engine was the more economically loaded than any of the other test runs. On this run the engine efficiency as well as the boiler and engine efficiency was very high, although not as high as the average compound efficiency.

"It appears from the results found that the compound gives a higher evaporation than that of the simple. The relative efficiency over that of the simple being about 5.8 per cent.

"On these runs where the speed maintained was highest and the dynamometer horse power least, due obviously to an under loaded train, the economy of the engines is the smallest. Thus on run No. 3 of simple engine the speed maintained was higher and the average draw bar pull lower than for any other run. The B. T. U. per dynamometer horse power per hour is 25 per cent. greater than for any other run of either engine. This shows that on this run the engine was greatly underloaded and was running very uneconomically.

"It goes to show by an examination of the various runs of both engines, that when a locomotive attains a high rate of speed, a comparative small addition of load does not affect the coal consumption proportionately. This is shown particularly by glancing at the average draw bar pull and speed maintained by the simple engine on her first run, and the very uneconomical results obtained by the same engine on her third run.

"Run No. 1 of the compound also presents this feature of an uneconomical load.

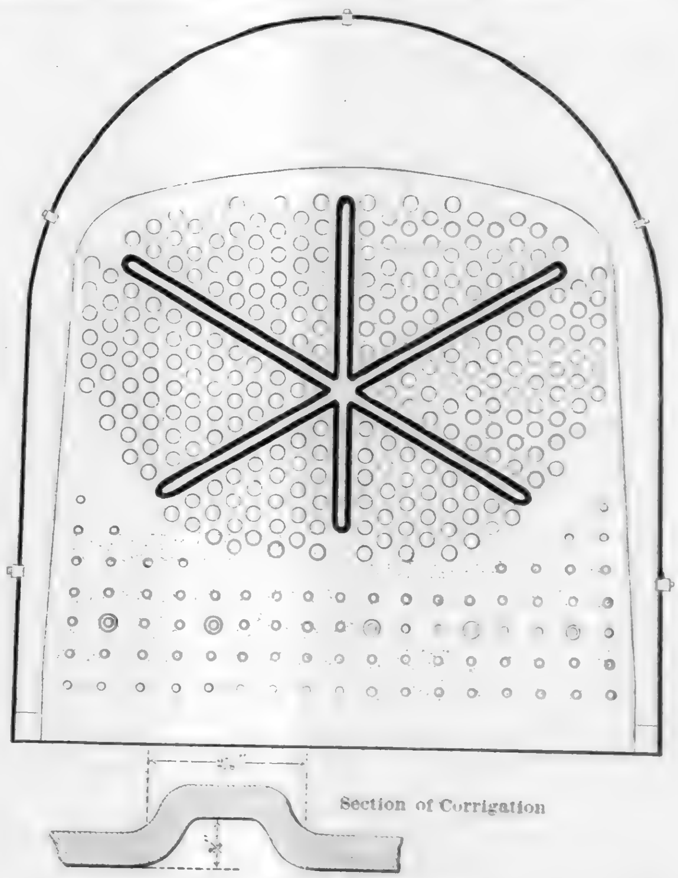
"If we consider all the runs of each engine, the saving of fuel in favor of the compound is 11 per cent. But we think it but fair in the final comparison to throw out those runs where the engines were greatly underloaded.

"Doing this and throwing out run No. 3 of simple engine and run No. 1 of compound engine, we get as a final and correct comparison a saving of 4.35 per cent. of B. T. U. per dynamometer horse power per hour in favor of the compound."

THE BOYCE OFF-SET FLUE SHEET.

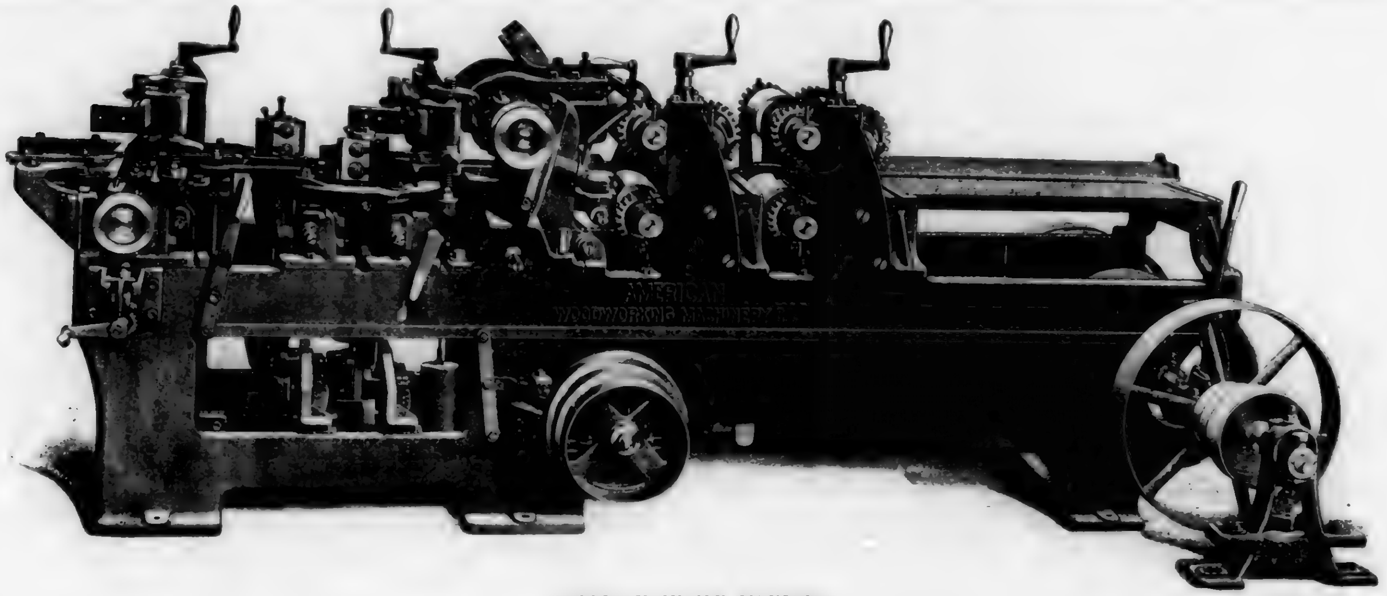
The accompanying illustration shows a firebox flue sheet which has been stiffened by means of corrugations pressed into the sheet. These corrugations are about 2⅞ ins. wide and ¾ of an inch deep and radiate from the centre in six directions to the edge of the section of the sheet covered by the flue holes.

The object of this is to so stiffen the sheet that it will better hold its shape and thus prevent the tendency to work on the rear end of the flues and cause them to leak. The corrugations necessitate the omitting of flues in the rows, as shown, which will result in better circulation around the flues and also by the proper location of washout plugs makes it possible to more thoroughly cleanse the flue sheet; it will, however, somewhat reduce the flue heating surface.



BOYCE OFF-SET FLUE SHEET.

This sheet is the invention of Mr. John J. Boyce, boiler shop foreman at the Burnside shops of the Illinois Central Railroad, and is being handled by the Boyce Off-Setting Flue Sheet Company, Room 4, 12 Sherman Street, Chicago, Ill.



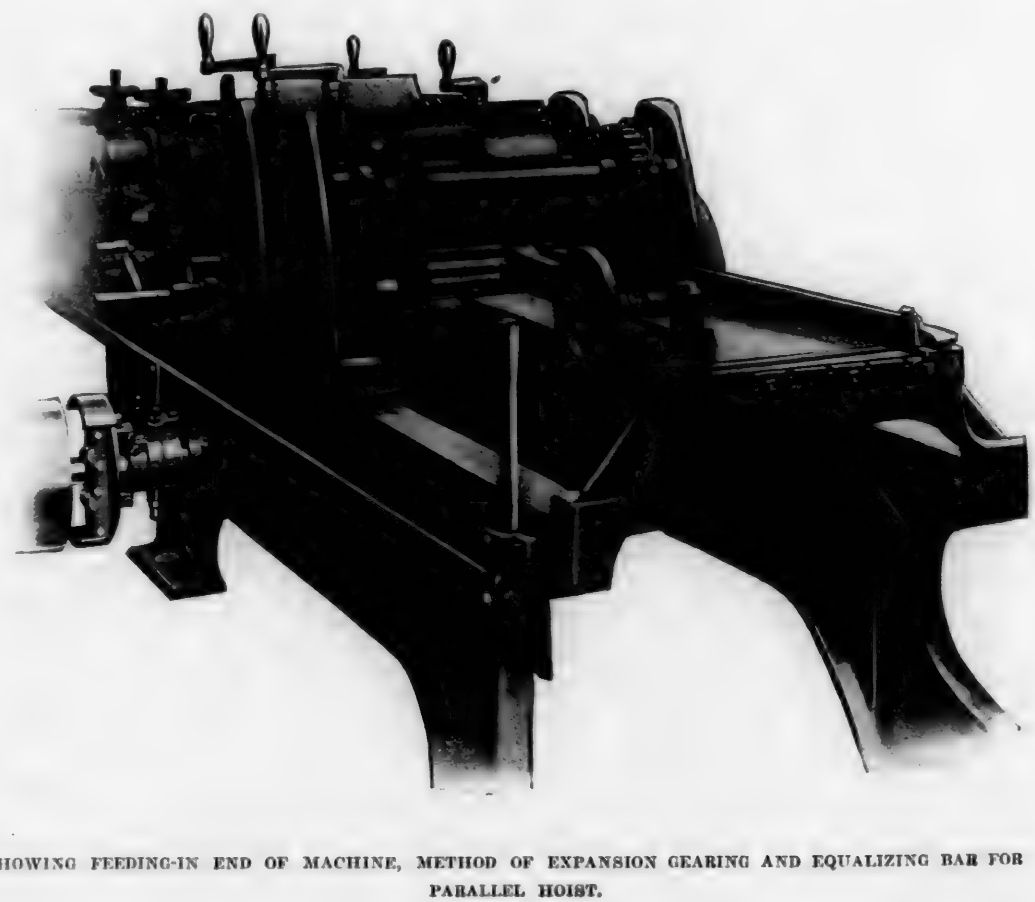
AMERICAN INSIDE MOULDER.

AMERICAN INSIDE MOULDER.

The American inside moulder, illustrated herewith, embodies all the late improvements, is strong and substantial, and has a capacity 12 and 14 ins. wide by 6 ins. thick. The long frame gives ample length of cylinder and side spindle belts, also good clearance around the cylinder and side heads. The feed is powerful, consisting of four large rolls, all geared on each end, weighted and fitted with a parallel lifting device, operated by one screw and having ball bearings. Springs are supplied to hold the stock to guide. The cylinders are of hammered crucible steel forgings. The bearings are of large diameter, running in self-oiling boxes. The boxes are connected by a yoke across machine, and the ends are securely clamped. The top cylinder is adjustable vertically by a crank and is clamped in position on both cylinder posts from the operating side of the machine. The screws and bevel gears for raising the top cylinder are housed within the cylinder posts, free from dirt and dust. The bottom cylinder moves laterally and has a parallel hoist. Both cylinders have a horizontal movement across the machine, to line to cut without disturbing the vertical adjustment of the heads.

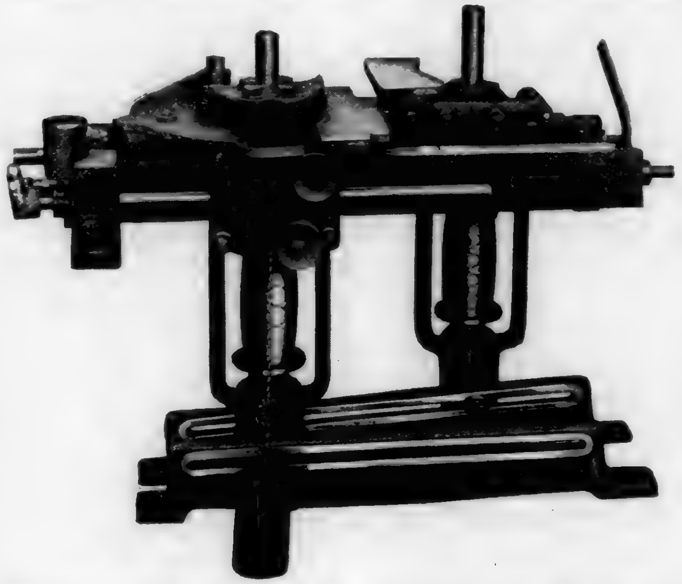
The plate under the top cutter head is slotted so that the cutters may be used to swing below the bed line to any depth of cut. It is bolted to the frame and may be easily removed, planed up and replaced. The chip breaker for the top head is adjustable to work as near the cutting edge of the knife as safety will permit and allow the knives to project so as to cut 3 ins. deep. The pressure bar and chip breaker for the lower head are adjustable for a 3-in. cut, the clamping bolts being on top and easy of access. The pressure bars after the cut of the top head, and over the lower head, are supported on both ends, adjustable quickly by screws on both ends, and swing up and back when required for setting up. The shoe holders on these bars are compound; that is, they take a shoe flat or on edge, as required.

The side spindles are large and run in self-oiling yoke boxes, tilt in either direction, are adjustable from both sides of the machine, and have a quick-acting wedge clamping device. The side heads are of hammered crucible steel forgings, with four sides, lipped and slotted, have the same swing and take the same knife and bolt as on the top and bottom cylinders. The side chip breakers are adjustable to admit of a 3-in. cut. The toe pieces that come in contact with the stock are removable and changeable.



SHOWING FEEDING-IN END OF MACHINE, METHOD OF EXPANSION GEARING AND EQUALIZING BAR FOR PARALLEL HOIST.

All short guides after the cut are adjustable across the machine, as well as to and from the cutters. The end of the bed swings down to admit of easy access to the bottom head, and the plate after the cut adjusts itself to any change of cut of the lower head. The plates that support the stock between the side heads are adjustable for any depth of cut, and the side yokes and bars which support them are also adjustable vertically to compensate for any wear. A friction cone feed gives three changes of speed and is stopped and started from the feeding-in end, as well as at the side of the machine near the side heads. An extra cone, giving six changes, is furnished when ordered. The cutter head pulleys are pneumatic, carefully fitted to a true taper and held by a nut. These moulders are made by the American Wood Working Machinery Company.

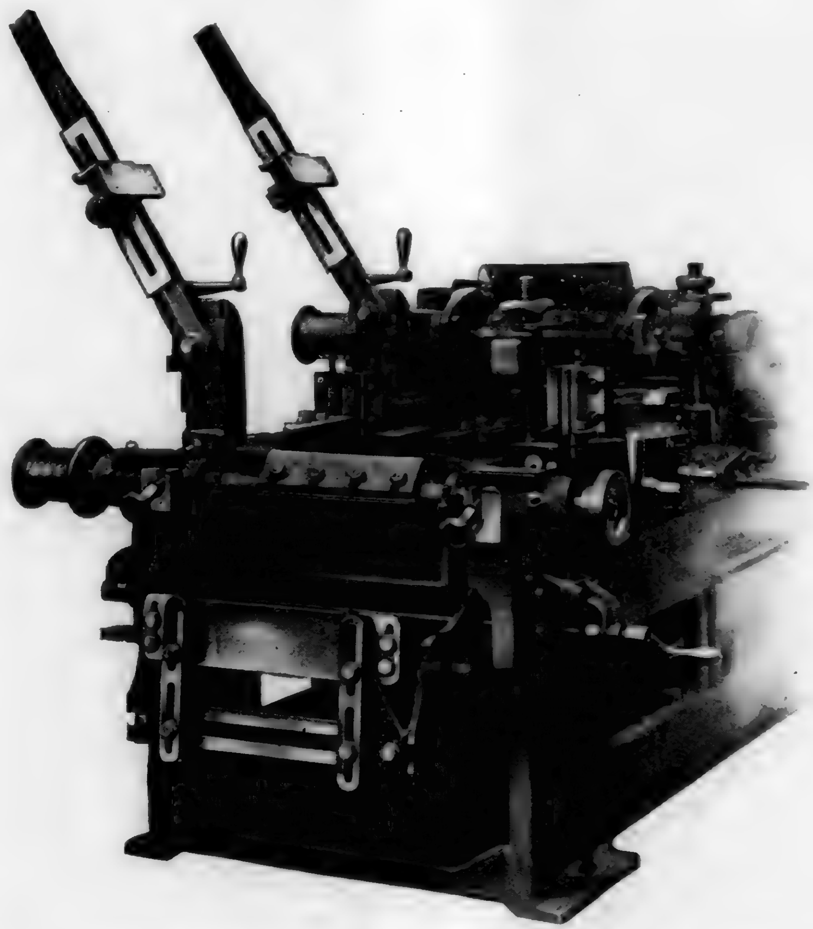


MATCHER STOCKS REMOVED FROM MACHINE, SHOWING GENERAL MANNER OF CONSTRUCTION AND METHOD OF LOCKING.

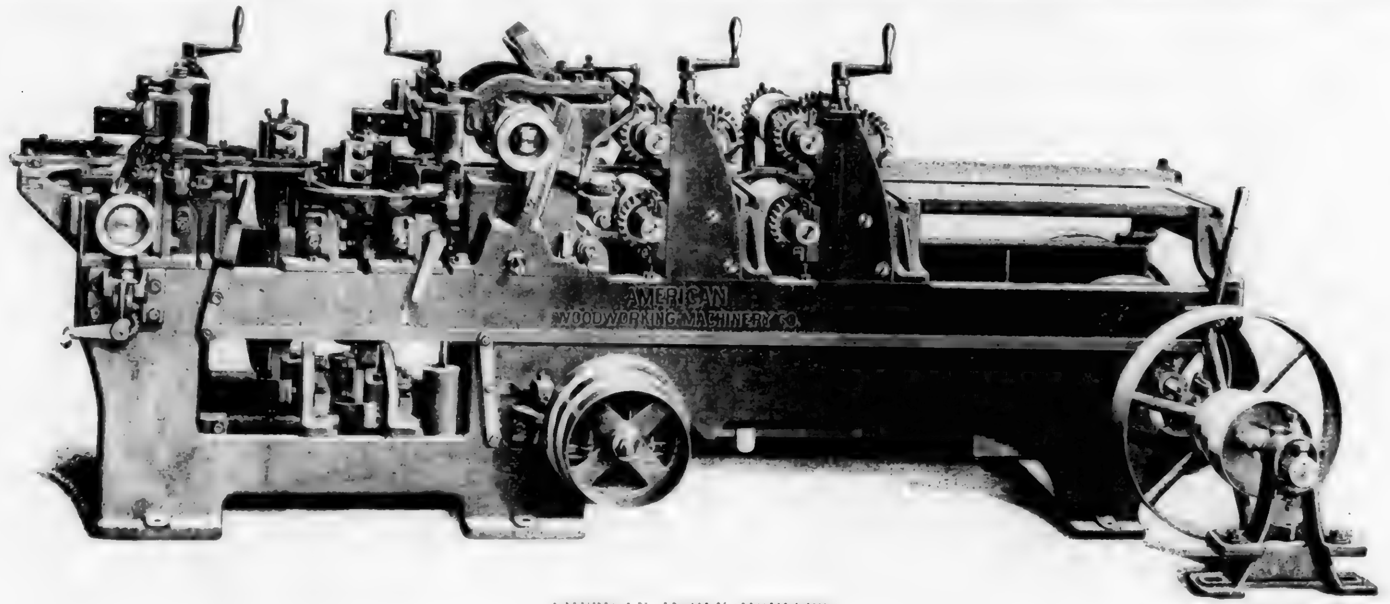
The Balanced Compound Locomotive.—Locomotives have become too large to permit of continuing indefinitely the mere increase of size and weight. More scientific development is needed. The usual methods of counterbalancing answer very well for compartively light locomotives, but as locomotives become larger and the parts become heavier the internal stresses upon the engine itself, due to the inertia of the parts, and the effect upon the track of the unbalanced counter-weights, renders it necessary to devise a better scheme of balancing. In ordinary practice, counterweights are added to the driving wheels for the purpose of balancing the reciprocating parts, but the revolving weights themselves need balancing when near the top and bottom of their paths. When in these positions the counterbalance weights tend to change the weight on the driving wheels, due to the centrifugal action, acting vertically upward when the weights are near the top of their path, and acting vertically downward when they are near the bottom. The counterweights, therefore, tend to lift the locomotive in the one case, and tend to increase the weight on the rails in the other case. This causes the so-called "hammer blow" upon the rail, and because this so-called "hammer blow" sometimes amounts to 25 per cent. of the static weight on the rails, it becomes exceedingly important in limiting the weight allowed upon driving wheels. By using four cylinders and balancing reciprocating parts with other reciprocating parts, and revolving weights with revolving weights, a practically constant pressure on the rail is secured, which renders it permissible to increase the weight on the driving wheels without increasing the destructiveness upon the track. By this permissible increase of driving wheel load a larger boiler may be carried, which is greatly to be desired in locomotive practice to-day.

On the Pennsylvania testing plant at St. Louis the Cole four-cylinder balanced compound operated for a full hour at a speed of 75 miles per hour, thus indicating a remarkable capacity. Incidentally, economy of fuel and water constitute attributes of this type of locomotives, and in the constructive features it is found to be possible to materially lighten the parts because the work is divided among a larger number of them. The subdivision of the power reduces the fiber stresses on each of these parts, and the disturbing influences of very heavy rods and reciprocating parts are avoided. The effect of reciprocating parts upon the structure of the engine as the movements of these parts rapidly change in direction has probably never had the attention which its importance merits. For high-speed passenger service, and also for freight service, the four-cylinder balanced locomotive presents advantages which should be tested to the utmost.—*Mr. G. M. Basford, at Purdue University.*

Steel Railroad Ties.—An order for 80,000 steel ties, or sufficient to lay thirty miles of track, was recently placed with the Carnegie Steel Company by the Bessemer Railroad of the United States Steel Corporation. The ties will be laid in continuous stretches instead of a number of short portions, as has been done by the various railroads that are experimenting with this type of tie.—*Engineering Record.*



SHOWING REAR TABLE DOWN AND ALL PRESSURE BARS UP, GIVING AMPLE ROOM FOR SETTING UP MACHINE.



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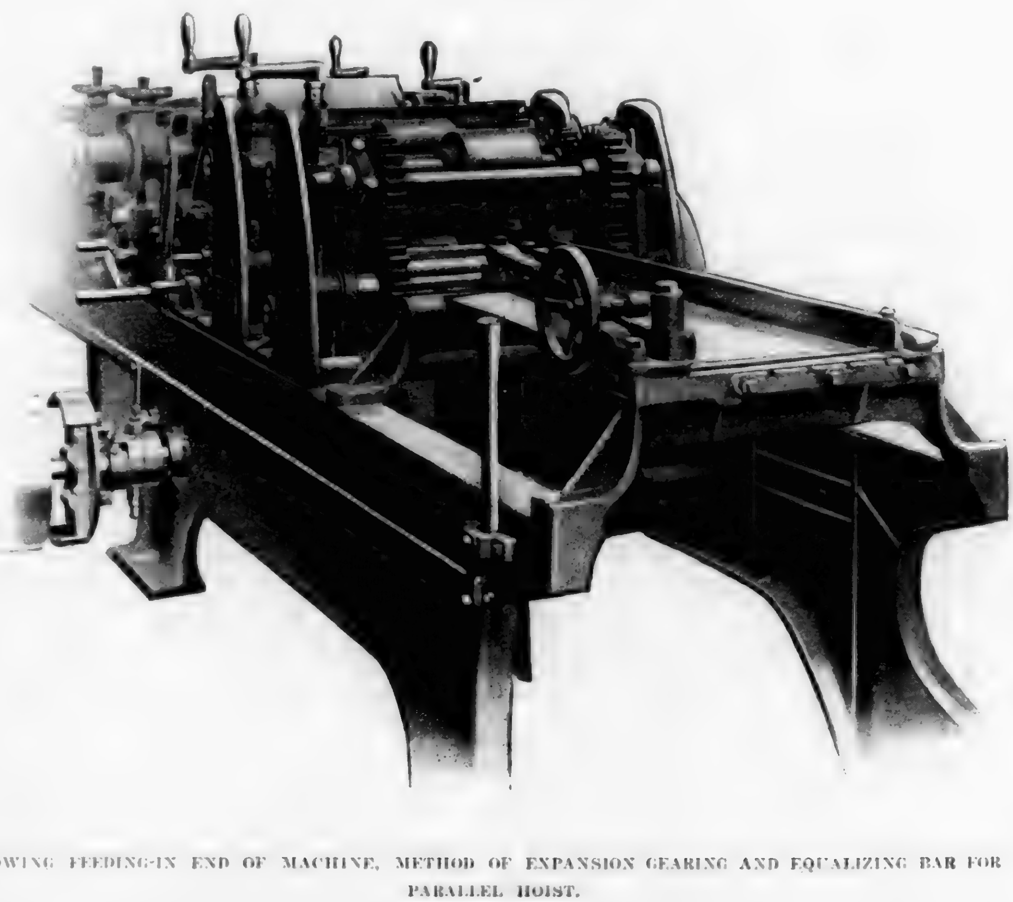
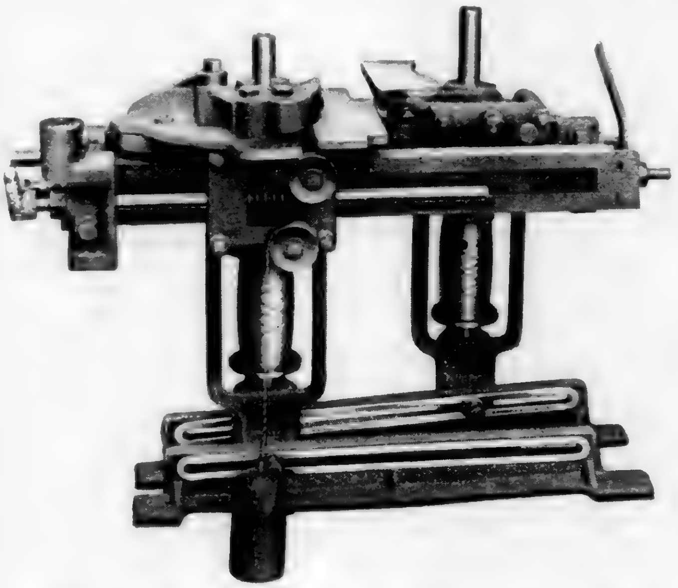


SHOWING FEEDING-IN END OF MACHINE, METHOD OF EXPANSION GEARING AND EQUALIZING BAR FOR PARALLEL HOIST.

All short guides after the cut are adjustable across the machine, as well as to and from the cutters. The end of the bed swings down to admit of easy access to the bottom head, and the plate after the cut adjusts itself to any change of cut of the lower head. The plates that support the stock between the side heads are adjustable for any depth of cut, and the side yokes and bars which support them are also adjustable vertically to compensate for any wear. A friction cone feed



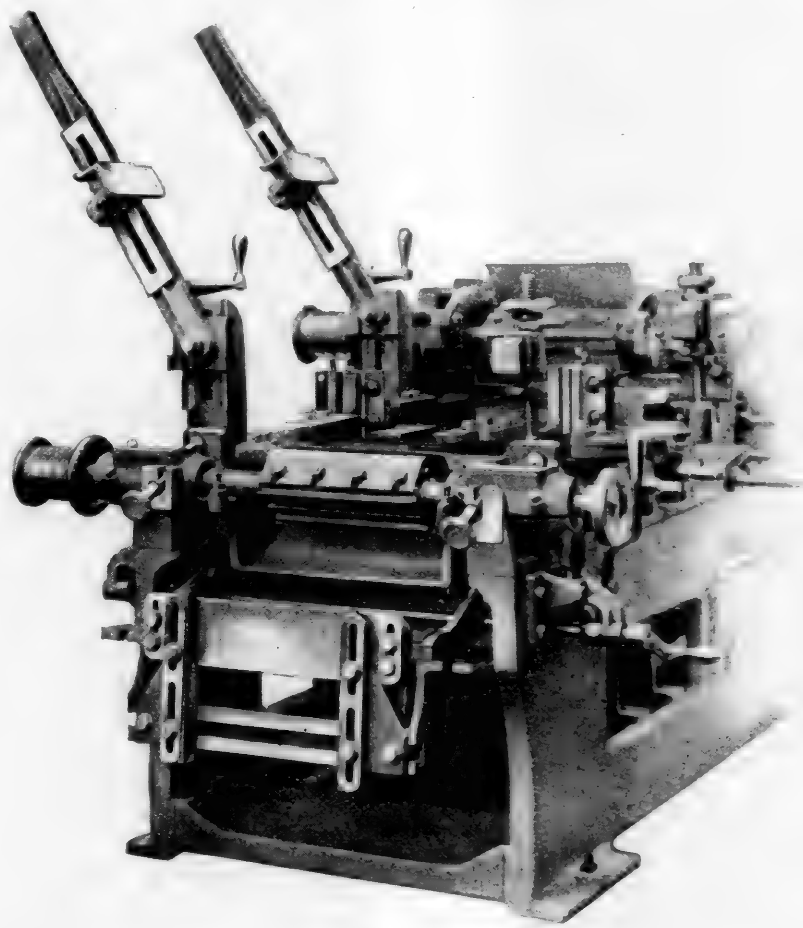
MATCHER STOCKS REMOVED FROM MACHINE, SHOWING GENERAL MANNER OF CONSTRUCTION AND METHOD OF LOCKING.

gives three changes of speed and is stopped and started from the feeding-in end, as well as at the side of the machine near the side heads. An extra cone, giving six changes, is furnished when ordered. The cutter head pulleys are pneumatic, carefully fitted to a true taper and held by a nut. These moulders are made by the American Wood Working Machinery Company.

THE BALANCED COMPOUND LOCOMOTIVE.—Locomotives have become too large to permit of continuing indefinitely the mere increase of size and weight. More scientific development is needed. The usual methods of counterbalancing answer very well for compartively light locomotives, but as locomotives become larger and the parts become heavier the internal stresses upon the engine itself, due to the inertia of the parts, and the effect upon the track of the unbalanced counter-weights, renders it necessary to devise a better scheme of balancing. In ordinary practice, counterweights are added to the driving wheels for the purpose of balancing the reciprocating parts, but the revolving weights themselves need balancing when near the top and bottom of their paths. When in these positions the counterbalance weights tend to change the weight on the driving wheels, due to the centrifugal action, acting vertically upward when the weights are near the top of their path, and acting vertically downward when they are near the bottom. The counterweights, therefore, tend to lift the locomotive in the one case, and tend to increase the weight on the rails in the other case. This causes the so-called "hammer blow" upon the rail, and because this so-called "hammer blow" sometimes amounts to 25 per cent. of the static weight on the rails, it becomes exceedingly important in limiting the weight allowed upon driving wheels. By using four cylinders and balancing reciprocating parts with other reciprocating parts, and revolving weights with revolving weights, a practically constant pressure on the rail is secured, which renders it permissible to increase the weight on the driving wheels without increasing the destructiveness upon the track. By this permissible increase of driving wheel load a larger boiler may be carried, which is greatly to be desired in locomotive practice to-day.

On the Pennsylvania testing plant at St. Louis the Cole four-cylinder balanced compound operated for a full hour at a speed of 75 miles per hour, thus indicating a remarkable capacity. Incidentally, economy of fuel and water constitute attributes of this type of locomotives, and in the constructive features it is found to be possible to materially lighten the parts because the work is divided among a larger number of them. The subdivision of the power reduces the fiber stresses on each of these parts, and the disturbing influences of very heavy rods and reciprocating parts are avoided. The effect of reciprocating parts upon the structure of the engine as the movements of these parts rapidly change in direction has probably never had the attention which its importance merits. For high-speed passenger service, and also for freight service, the four-cylinder balanced locomotive presents advantages which should be tested to the utmost.—*Mr. G. M. Basford, at Purdue University.*

STEEL RAILROAD TIES.—An order for 80,000 steel ties, or sufficient to lay thirty miles of track, was recently placed with the Carnegie Steel Company by the Bessemer Railroad of the United States Steel Corporation. The ties will be laid in continuous stretches instead of a number of short portions, as has been done by the various railroads that are experimenting with this type of tie.—*Engineering Record.*



SHOWING REAR TABLE DOWN AND ALL PRESSURE BARS UP, GIVING AMPLE ROOM FOR SETTING UP MACHINE.

PERSONALS.

Mr. J. J. Bartholomew has been appointed air brake inspector of the St. Louis-Southwestern.

Mr. H. A. Simms has been appointed general car inspector of the Illinois Central Railroad, succeeding Mr. R. C. Powell.

Mr. J. M. McMullin has been appointed master mechanic of the Lehigh Valley Railroad at Sayre, Pa.

Mr. Williard Kells, master mechanic of the Lehigh Valley at Sayre, Pa., has been transferred to Buffalo, N. Y.

Mr. Andrew M. McGill, a general foreman of the New York, New Haven & Hartford, has been appointed a master mechanic on the Lehigh Valley.

Mr. S. D. Kinney has resigned as superintendent of shops of the Gulf, Colorado & Santa Fe, at Cleburne, Tex., and the position has been abolished.

Mr. B. P. Meyers has been appointed master mechanic of the International & Great Northern, with headquarters at Taylor, Tex., to succeed Mr. C. M. McLain.

Mr. J. W. Cain has been appointed assistant engineer of tests of the Atchison, Topeka & Santa Fe, with office at Topeka, Kan.

Mr. T. E. Layden has been appointed assistant engineer of tests of the Atchison, Topeka & Santa Fe Coast Lines, with headquarters at San Bernadino, Cal.

Mr. T. P. Anderson has been appointed to the new office of superintendent of tests of the Cincinnati, New Orleans & Texas Pacific, with headquarters at Lexington, Ky.

Mr. O. M. Foster, general road foreman of engines of the Lake Shore & Michigan Southern, at Cleveland, Ohio, has been appointed assistant master mechanic at Elkhart, Ind.

Mr. M. J. McGraw, master mechanic of the Missouri Pacific at Fort Scott, Kan., has been appointed master mechanic at St. Louis, Mo.

Mr. W. C. Walsh, master mechanic of the Southern Indiana Railway, at Bedford, Ind., has been appointed master mechanic of the Missouri Pacific at Fort Scott, Kan.

Mr. L. Bartlett, master mechanic of the St. Louis Division of the Missouri Pacific, has retired after a service of 44 years with that road. He has been master mechanic for 21 years.

Mr. F. G. Grimshaw has been appointed assistant master mechanic of the Pennsylvania at Ormsby, Pa.

Mr. J. J. Walsh, master mechanic of the Pennsylvania Lines West of Pittsburgh, at Chicago, has been transferred to Logansport, Ind.

Mr. G. B. Fravel, master mechanic of the Pennsylvania Lines West of Pittsburgh, at Logansport, Ind., has been transferred to Dennison, Ohio.

Mr. P. F. Smith, Jr., master mechanic of the Pennsylvania Lines West of Pittsburgh, at Dennison, Ohio, has been transferred to Columbus, Ohio.

Mr. N. M. Loney, assistant engineer of motive power of the Pennsylvania Lines West of Pittsburgh, at Fort Wayne, Ind., has been appointed master mechanic at Chicago, Ill.

Mr. R. H. Smith, roundhouse foreman of the Great Northern Railroad at St. Paul, Minn., has been appointed master mechanic at Crookston, Minn.

Mr. W. W. Breckenridge, division master mechanic of the Great Northern Railway at Crookston, Minn., has been transferred to Great Falls, Mont.

Mr. F. M. Fryburg, division master mechanic of the Great Northern Railway at Great Falls, Mont., has been appointed general master mechanic of the Central District, with headquarters at Minot, N. D.

Mr. W. C. A. Henry, master mechanic of the Pennsylvania Lines West of Pittsburgh, at Columbus, Ohio, has been appointed assistant superintendent of motive power of the Southwest System, with headquarters at Columbus, Ohio.

Mr. R. D. Hawkins, general master mechanic of the Central District of the Great Northern Railway, has been appointed mechanical engineer, with headquarters at St. Paul, Minn., to succeed Mr. G. Willius, who has resigned to go into other business.

Mr. G. A. Gallagher, master mechanic of the Illinois Southern at Sparta, Ill., has been appointed master mechanic of the Southern Indiana, with headquarters at Bedford, Ind., to succeed Mr. W. C. Walsh.

Mr. W. J. Tollerton, master mechanic of the Oregon Short Line at Pocatello, Idaho, has been appointed superintendent of motive power of the Southwestern and Choctaw districts of the Chicago, Rock Island & Pacific, with headquarters at Topeka, Kan.

Mr. Frank Huffsmith, superintendent of rolling stock and motive power of the International & Great Northern Railway, has resigned and the office is abolished. Mr. George R. Bunter, general foreman, has been apopinted master mechanic, and Mr. J. W. Buck, general storekeeper.

Mr. E. D. Bronner, recently appointed superintendent of motive power of the Lake Shore & Michigan Southern, has, at his own request, been transferred to his former position of superintendent of motive power and equipment on the Michigan Central. Owing to the illness of his daughter, Miss Harriett Bronner, he has been granted a leave of absence of six months. Mr. D. R. MacBain, recently appointed assistant superintendent of motive power, has been appointed acting superintendent of motive power during Mr. Bronner's absence.

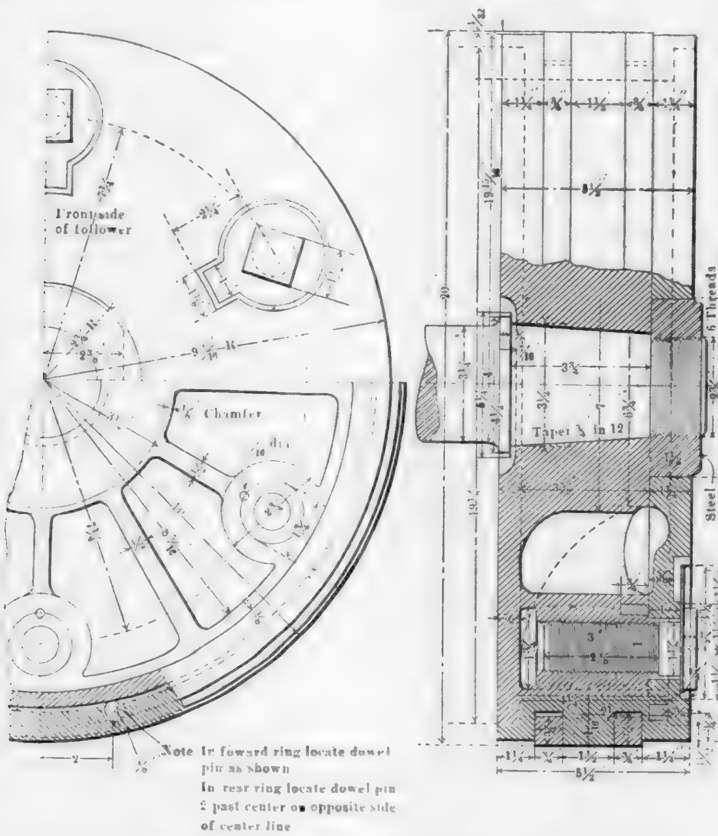
Mr. Le Grand Parish, who was recently appointed superintendent of motive power and equipment of the Michigan Central, has been transferred and appointed superintendent of motive power of the Lake Shore & Michigan Southern, the Lake Erie & Western, the Lake Erie, Alliance & Wheeling, the Dunkirk, Allegheny Valley & Pittsburgh, the Indiana Harbor and the Chicago, Indiana & Southern, with headquarters at Cleveland, Ohio. Mr. Parish was born at Friendship, N. Y. After leaving school he worked in several machine shops, after which he entered the laboratory of Thomas A. Edison. In 1889 he went with the Gilliland Electric Company at Adrian, Mich. In July, 1891, he entered the service of the Lake Shore & Michigan Southern Railway. From July, 1894, to November, 1896, he was chief clerk of the car department at Englewood, Ill., after which he was general foreman until November, 1899. He was then appointed master car builder of the Western division, and, in addition to this, he was, in 1900, made master car builder of the Michigan division. November 1, 1904, he was appointed assistant superintendent of motive power.

Mr. Michael Dunn, superintendent of motive power of the Southwest System, Pennsylvania Lines West of Pittsburgh, died recently at his home in Columbus, Ohio. Mr. Dunn was born January 25, 1857, at Lancaster, Pa. He graduated from Commercial College at Richmond, Ind., August, 1872, and entered railway service as a messenger on the Pittsburgh, Cincinnati & St. Louis Railway, now known as the Pittsburgh, Cincinnati, Chicago & St. Louis Railway (South-

west System, Pennsylvania Lines West of Pittsburgh), and remained with that road until his death. From August, 1872, until July, 1874, he served as a messenger at Richmond, Ind., after which he served as storekeeper until 1877 and then as shop clerk until September, 1878, when he was enrolled as machinist apprentice, serving in that capacity until 1882, and then as machinist until May, 1890. He was then appointed roundhouse foreman at Cincinnati, Ohio, and in February, 1891, was appointed general foreman at Cincinnati, and from September, 1893, to January, 1896, was road foreman of engines at the same place. In 1896 he was appointed master mechanic at Dennison, Ohio, and in March, 1903, master mechanic at Columbus, Ohio. He was appointed superintendent of motive power in August, 1903.

CAST STEEL PISTONS.

A correspondent has inquired concerning approved practice in the use of cast steel for locomotive pistons. The accompanying engraving illustrates a design which has been used for some time on the Chicago & Northwestern Railway, and has overcome the difficulty of breakage in pistons made of cast iron. The follower bolts are screwed into brass bushings, which are themselves screwed into bosses in the spider, in order to prevent the sticking of the bolts in the cast steel spider. This drawing illustrates a bull ring piston, and it is likely to interest readers other than the correspondent referred to.



CAST STEEL PISTONS—C. & N. W RY.

THE WORLD'S RECORD IN GUNNERY has been established on the battleship *Ohio* by D. M. Dean, whose score was thirteen bulls-eyes out of thirteen shots in one minute, with a 6-inch gun. The *Ohio* was steaming at 10 knots at the time, and the target was distant 1,600 yards. The best previous record for this size gun was eleven hits out of fourteen shots, made by one of the gun pointers in the British navy. When it is realized that as recently as the Spanish war the 6-inch guns, as fitted on the *Oregon*, were capable of only about two shots per minute, the importance of this record and the immense forward strides which it indicates become all the more apparent.—*International Marine Engineering.*

THE YOUNG MAN AND THE MOTIVE POWER DEPARTMENT.—The past has left us a somewhat unfortunate legacy, of which the result only needs attention on this occasion. The result referred to is seen in the tendency for young men to be easily enticed away from railroad service after they have spent years in preparation for it and are fairly on the road to win success. As a legacy of the earlier days of railroads in this country motive power positions are not, as a general rule, made sufficiently attractive. This, however, is to be changed, and the power to bring the change lies in the young men who now hold responsible motive power positions and in those who are to hold them in the near future. As motive power problems and possibilities become better appreciated and better understood, the railroads will surround motive power positions with greater attractions, which will eventually render it thoroughly worth while for the very best mechanical talent to prepare for work which, because of its attractions, will preserve this talent to the railroads. There are signs on the horizon to-day that this happy state is coming soon.—*Mr. G. M. Basford, at Purdue University.*

ENGINE HOUSE SMOKE JACKS.—Engine house smoke jacks should be fixed, the bottom opening should be not less than 42 ins. wide, and long enough to receive the smoke from the stack at its limiting positions, due to adjustment of the driving wheels, to bring the side rods in proper position for repairs. The bottom of the jack should be as low as the engines served will allow, and it should be furnished with a drip trough. The slope upward should be gradual to the flue; the size of the flue for the largest locomotives should not be less than 42 ins. in diameter; a damper should be provided in the flue—easily adjusted from the floor, and the material used should be non-combustible and noncorrosive.—*Committee report, American Railway Engineering and Maintenance of Way Association.*

VALUE OF TECHNICAL PAPERS.—The advancing foreman of to-day must be up to new ideas and keep moving; he has no time to sit with his hands folded. The proper use of mechanical literature is the foundation of success. The good, energetic mechanic waits hourly for his mechanical journal to arrive; how would our minds be enlightened if it were not for this? We would never have anything before us that would give us any reason to improve or make improvement. Every month there is something new that is very beneficial to the mechanic, and, I am sorry to say, there is not one-half of the mechanics reading these papers that should be. The country has produced some of the finest graduates in the mechanical line, and it is these who are worrying their minds about modern mechanics and improvements that when published are beneficial to you and me. I think if every foreman would stop long enough to think where he is in this hustling, modern, improved mechanical world, he would subscribe for more mechanical literature.—*G. W. Keller, before the Convention of the International Railway General Foremen's Association.*

BOOKS.

Transactions of the American Society of Mechanical Engineers. Vol. XXVI, 1905, 841 pages. Published by the Society, 12 West Thirty-first Street, New York City.

This volume contains the proceedings of the fiftieth meeting held in New York City, 1904, and the fifty-first meeting held in Scranton, Pa., 1905. The papers of special interest to motive power officials are: Fuel Consumption of Locomotives by G. R. Henderson, Road Tests of Brooks Passenger Locomotives by E. A. Hitchcock, Microstructive and Frictional Characteristics in Bearing Metal by Melvin Price.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

SOME COMMENTS ON AIR BRAKE HOSE.—Under this title the Boston Belting Company, Boston, Mass., has issued a small pamphlet directing attention to certain pertinent facts, as indicated by a careful study of the tests reported at the recent convention of the Master Car Builders' Association by the committee on air brake hose specifications.

GASOLINE ELECTRIC MOTOR CAR.—William B. Strang, 15 Wall Street, New York City, has issued a pamphlet entitled "Success of the Strang Gas-Electric Railway Car System." It describes the results which have been gained in service from the car "Ogerita," which was described on page 103 of our March, 1906, issue.

MOTORS.—The Crocker-Wheeler Company, Ampere, N. J., is sending out bulletin No. 66, which describes their new type W motors. These were designed primarily for use in rolling mills and are of great mechanical strength, have sealed bearings, excluding all dirt, and are fireproof. They are arranged for outputs of 25, 50, 75 and 100 h. p., and are designed for 220 volts only.

WOODWORKING MACHINERY.—A handsomely illustrated 200-page catalog has been issued by the S. A. Woods Machine Company, Boston, Mass., describing the line of woodworking tools made by them. These include heavy timber sizers and matchers; fast feed planers and matchers; flooring machines; double surface planers; moulders, inside, outside and variety; automatic railway cut-off saw; lock corner box machines; automatic knife grinder; hollow chisel mortisers and universal boring attachments.

OIL TANKS AND CABINETS.—We have received from S. F. Bowser & Company, Fort Wayne, Ind., copies of the 14th edition of catalog No. 1, concerning the Bowser self-measuring and computing oil outfits, and of the 5th edition of catalog No. 3, which describes the Bowser self-measuring factory, railroad and navy oil tanks and cabinets. These outfits are furnished in any desired size to handle oils of all kinds, and may be arranged to suit almost any conditions. They are very completely described in these two catalogs.

FLEXIBLE STAYBOLTS.—The Flannery Bolt Company, Pittsburgh, Pa., is sending out a small pamphlet entitled "A Few Installations of the Tate Flexible Staybolt." It contains a number of interesting views showing applications of these staybolts to different types of locomotive boilers. Special attention is directed to the importance of providing the proper tools for the application of these bolts. A pamphlet describing the tools to be used for this purpose, and containing instruction for applying the Tate Flexible Staybolt, will be furnished upon application.

KEY-SEAT MILLING MACHINES.—Catalog No. 44 from the Newton Machine Tool Works, 24th and Vine Streets, Philadelphia, Pa., describes several types of key-seat milling machines made by them. One of these is for rapidly milling key-seats for feather keys, short splines and other work requiring one or both ends rounded up. The machine has both a horizontal and vertical spindle, and is built in two sizes. A machine is also shown for milling the two key-seats in locomotive axles accurately and at the same time.

ABUSES OF VALVES.—In an article on the "Abuse of Valves," published in *The Valve World*, Mr. R. T. Crane, president of Crane Co., says that in ninety-five cases out of a hundred leaky valves are due to abuse and carelessness on the part of the men who install them, rather than the defects in the valves themselves. If the few simple directions given by Mr. Crane for the installation and care of valves were generally followed much of the annoyance and expense due to leaky valves would be avoided. The article has been reprinted in the form of a poster suitable for hanging on the walls of engine rooms and shops, and all users of valves may obtain one or more copies free by writing Crane Co., Chicago. The posters are legibly printed in two colors on heavy calendered bristolboard.

LARGE STEAM AND ELECTRIC LOCOMOTIVES.—The American Locomotive Company, in a pamphlet just issued, presents a paper on this subject read before the New York Railroad Club by Mr. J. E. Muhlfeld, general superintendent of motive power of the Baltimore & Ohio Railroad. Extracts from the discussion of the paper are also reproduced. The paper opens with a description of the electric locomotive No. 7-8, built by the General Electric Company, giving details of its design and record of its performance since going into service in 1903 and statistics of the average cost of operation and maintenance per hundred miles run. Then follow several specifications of the requirements an electrical locomotive and its source of power should fulfil to produce efficiency and economy in railroad service. The next seven or eight pages are taken up with a description of the Mallet articulated compound, built by the American Locomotive Company, giving special features of design, and comparing it as to total weight, tractive power and hauling capacity with two consolidation locomotives which together were formerly required to do the work now done by the Mallet. Then follows a record of the performance of this locomotive for a period of one year—from January, 1905, to January, 1906—and a report as to the general condition of the machinery and boiler at the end of this time. Mr. Muhlfeld mentions some of the results obtained from this type of steam locomotive which cannot be duplicated by other single units of steam, electric or internal combustion locomotives in use on American railroads to-day, and gives a short resume of the requirements modern railroad motive power must fulfil. Following this is a statement of the equipment necessitated by the use of electricity for motive power, and that required where the steam locomotive is used. In the last three or four pages of the paper, the possibilities for electrification which some mountainous steam railroads present are pointed out, followed by a general discussion of the subject of steam versus electricity for motive power. Mr. Muhlfeld compares the electric and steam locomotive from the standpoints of efficient and economical operation and maintenance, pointing out the necessity of reducing the initial cost of electrification by increasing the efficiency and economy of present types of the stationary boiler and by improvements in the means of generating, distributing, converting and transmitting electrical current. In conclusion the author says that it is only by the harmonious co-operation of the electrical and mechanical engineer attacking the problem from the transportation and motive power standpoints, that we can hope to meet the present and future motive power requirements. The rest of the pamphlet is taken up with discussions of the paper by Mr. F. J. Cole, Mr. H. H. Vaughan of the Canadian Pacific Railway, Mr. W. B. Potter of the General Electric Company, Mr. Angus Sinclair and Mr. W. M. Smith, closing with a summing up by Mr. Muhlfeld.

NOTES.

PRESSED STEEL CAR COMPANY.—The office of this company in Mexico City has been changed from Calle de Gante No. 8 to Prolongacion del 5 de Mayo No. 9.

QUINCY, MANCHESTER, SARGENT COMPANY.—This company of Chicago announces the opening of its Priest snow flanger department. A large number of orders have already been booked, including 22 for Canada.

NORTON COMPANY.—Mrs. Frances A. W. McIntosh, formerly advertising manager of the Standard Tool Company, Cleveland, Ohio, and more recently connected with the advertising department of *Power*, New York, has taken charge of the publicity department of the Norton Company, Worcester, Mass.

CROCKER-WHEELER COMPANY.—This company has completed arrangements and opened an office and warehouse at No. 208 First Street, near Howard, San Francisco, Cal., with Mr. H. C. Baker as local manager. It has also opened an office at No. 447 Pacific Electric Bldg., Los Angeles, Cal., with Mr. L. Cummins as representative, and is arranging to establish an office in Seattle, Washington, in the near future.

ENGINEERING OPPORTUNITIES IN THE PHILIPPINES.—It has been announced that there will be a number of engineering vacancies in the Philippine service within the next few months, and that it is expected that an examination for these openings will be announced in a short time. The acting chief of this bureau is Frank McIntyre, Captain of the 19th U. S. Infantry, to whom requests for information can be addressed at the Bureau of Insular Affairs, War Department, Washington, D. C.

LOCOMOTIVE APPLIANCE COMPANY.—At the annual meeting of the stockholders of the Locomotive Appliance Company, which was held at their offices, Old Colony Building, Chicago, Ill., August 9, 1906, the following directors were elected for the ensuing year: Mr. Frank W. Furry, Mr. J. J. McCarthy, Mr. J. B. Allfree, Mr. Willis C. Squire, Mr. Ira C. Hubbell, Chicago, Ill.; Mr. Clarence H. Howard, Mr. H. M. Pflager, Mr. B. F. Hobart, Mr. C. A. Thompson, Mr. W. J. McBride, St. Louis, Mo.; Mr. J. H. McConnell, Pittsburgh, Pa.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL

OCTOBER, 1906.

MALLET ARTICULATED COMPOUND LOCOMOTIVE, TYPE 2-6-6-2.

GREAT NORTHERN RAILWAY.

The Great Northern Railway has recently received an order of five Mallet articulated compound locomotives from the Baldwin Locomotive Works, which have the distinction of being the heaviest locomotives in the world. They have a total weight of 355,000 lbs., of which 316,000 lbs. is on the drivers.

The satisfactory service given by the locomotive of this type on the Baltimore & Ohio R. R. during the past twenty months has proved the practicability of this monster machine for service under the most difficult conditions of grade and curvature. Mr. Muhlfeld, general superintendent of motive power of the Baltimore & Ohio Railroad, in his paper on "Large Steam and Electric Locomotives," delivered before the New York Railroad Club, February, 1906, stated that, "from the performance up to the present date (one year) it has been found that the following features embodied in the design of this locomotive have given entirely satisfactory results with respect to design, maintenance and operation: Flexible joints to the high and low-pressure cylinders. Receiver and exhaust pipes. Articulated frame. Intercepting, reducing and emergency valves. An intermediate chamber system of compounding and simpling. Combination hand and power reversing gear. Walschaert valve motion. Method of securing high-pressure cylinder to boiler. Tracking and riding qualities, going forward or backward around maximum curvature and when pushing, pulling or braking trains or running light. There has been no trouble on account of priming, and the results accomplished through the distribution of work over four instead of two main crank pins and auxiliary parts have been markedly satisfactory."

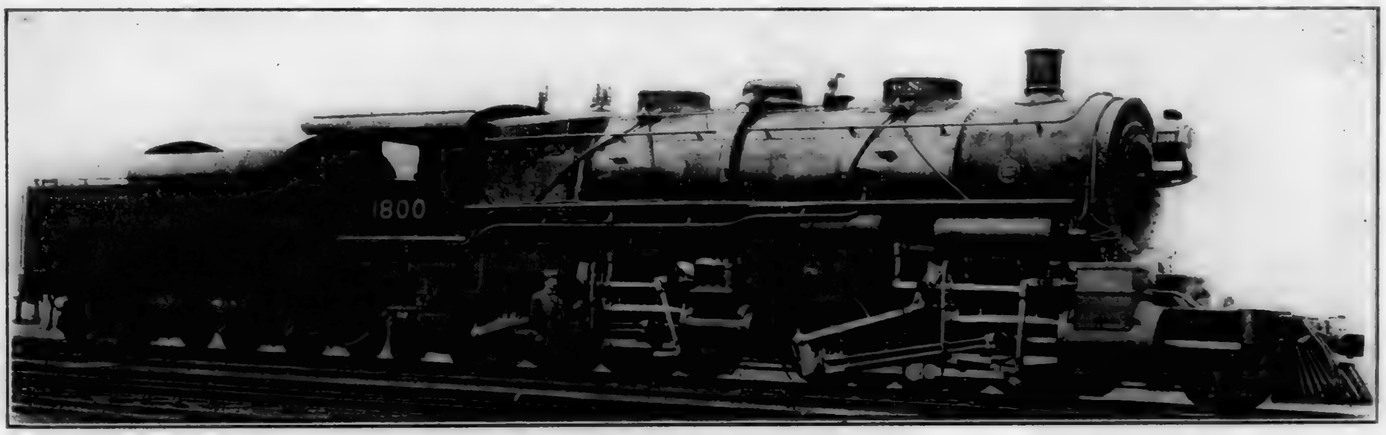
It was found that this locomotive would haul a heavier train over the same grades than two consolidation locomotives, which together (including tenders) weighed nearly 200,000 lbs. more than the Mallet engine.

The Great Northern engines differ from the one on the Baltimore & Ohio, which was very thoroughly illustrated and described in this journal in 1904 on pages 167, 237, 262 and 279, and in 1905 on pages 229 and 249; in the addition of leading and trailing trucks, type of boiler, and in many of the details.

By reference to the following table of the comparison of a few of the important dimensions and ratios it will be seen that while the Great Northern engines are greater in total weight they are somewhat less on drivers, and give a weight per axle of 26⅓ tons, as compared with 27⅞ tons. The steam pressure is 200 lbs. instead of 235, but this is more than equalized by the larger cylinders, so that the theoretical tractive effort, also increased by the 1-in. difference in diameter of drivers, is greater than on the earlier example.

Road	G. N.	B. & O.
Builder	Baldwin	American
Wheels	2-6-6-2	0-6-6-0
Total weight	355,000 lbs.	334,500 lbs.
Weight on drivers	316,000 lbs.	334,500 lbs.
Size, cylinders	21½&33x32 ins.	20&32x32 ins.
Diameter of drivers	55 ins.	56 ins.
Tractive effort	71,600 lbs.	70,000 lbs.
Steam pressure	200 lbs.	235 lbs.
Total wheel base	44 ft. 10 ins.	30 ft. 8 ins.
Driving wheel base, rigid	10 ft.	10 ft.
Total heating surface	5,658 sq. ft.	5,600 sq. ft.
Grate area	78 sq. ft.	72.2 sq. ft.
Weight on drivers ÷ tractive effort	4.41	4.78
Total weight ÷ total heating surface	62.8	59.9
Weight on drivers ÷ total heating surface	56	59.9
Tractive effort x diam. drivers ÷ total heating surface	697	700
Total heating surface ÷ vol. equiv. simple cylinders	271	295
Grate area ÷ vol. equiv. simple cylinders	3.75	3.85

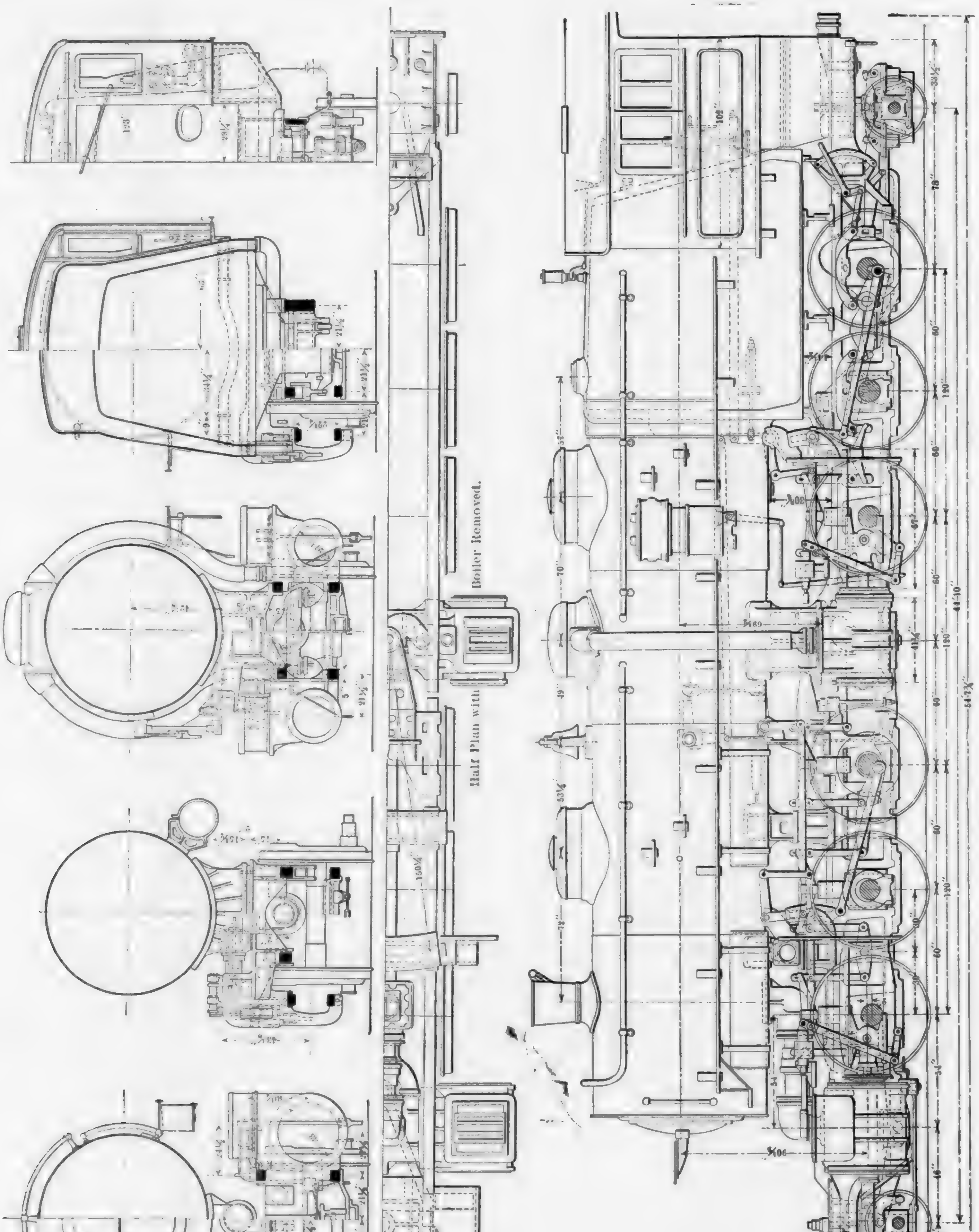
As regards the general size and capacity of the boiler the two locomotives are very nearly alike, the Great Northern engine, however, has the Belpaire type of firebox, while the radial stay design is used on the Baltimore & Ohio engine. They both have practically 5,600 sq. ft. of heating surface, the Great Northern engine having 21-ft. flues while the Baltimore & Ohio engine has flues 20 ft. 10¾ ins. long. The grate area in the later design has been made 78 sq. ft. instead of 72.2. These differences, in which the boiler on the Great Northern exceeds that on the Baltimore & Ohio, together with a smaller weight on drivers, affects the ratios to some slight extent, as will be seen in the table.



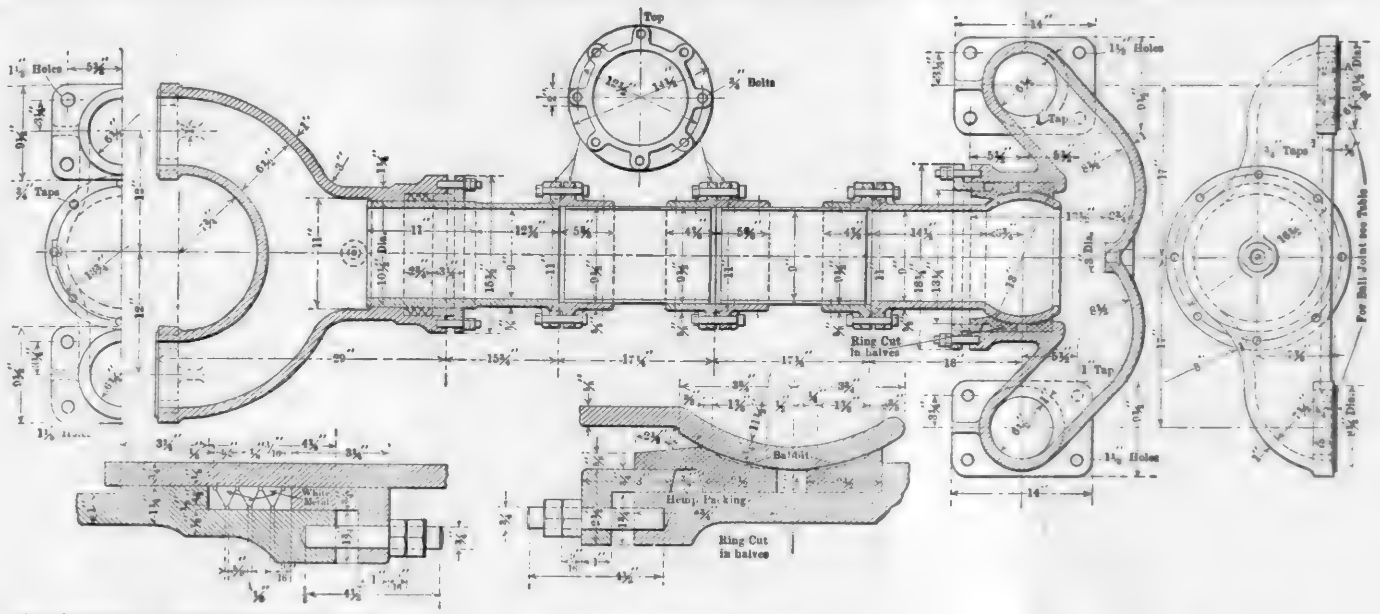
HEAVIEST LOCOMOTIVE—GREAT NORTHERN RAILWAY.

The boiler of the Great Northern engine measures 84 ins. at the front ring, and has the waist made up of three rings. The circumferential seam in the front of the dome is triple riveted, the others being double riveted. The horizontal seams have diamond welt strips. The back head of the Belpaire firebox is sloping, and the very short throat sheet is made vertical, the mud ring being horizontal. The water spaces around the firebox are large, measuring 6 ins. in front and 5 ins. on the sides and back at the mud ring, which space is gradually increased toward the crown sheet. The flues are spaced with ¾-in. bridges.

The dome, which because of clearance limits is built very low, is made in the form of a single steel casting; it is fitted with a Rushton throttle, which has two steam outlets, one on either side, and takes steam from the top only. The illustration showing the cross section of the dome makes this construction clear. The throttle chamber connects to bosses on the dome casting, with ball joints, and the steam passage is continued outward to steam pipes, which pass outside of the boiler shell to the high-pressure cylinders located directly below the dome. These outside pipes are heavily lagged, and connect to the dome and cylinder castings with the usual ground joints.

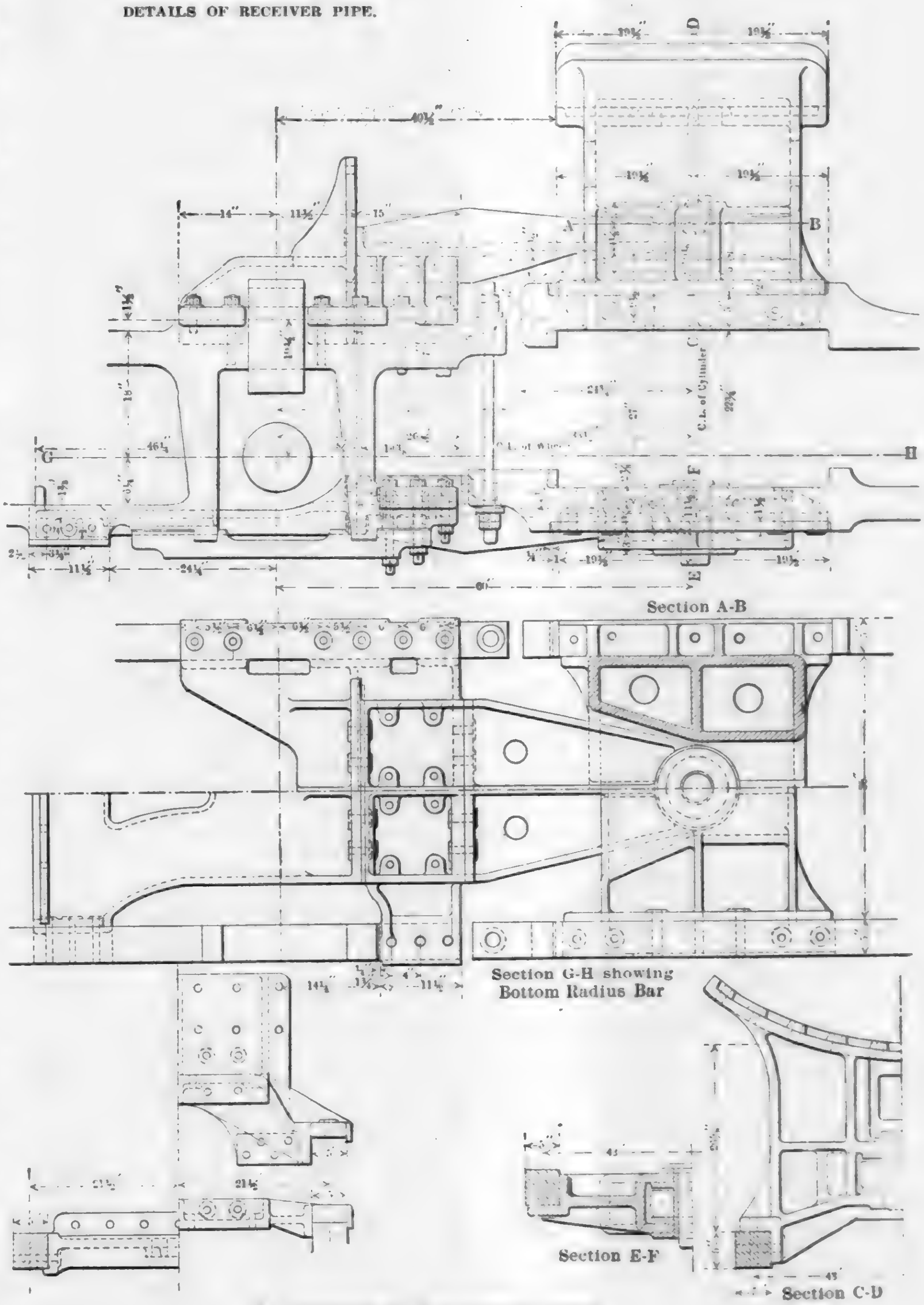


MALLET ARTICULATED COMPOUND LOCOMOTIVE, 2—6—6—2 TYPE—GREAT NORTHERN RAILWAY.

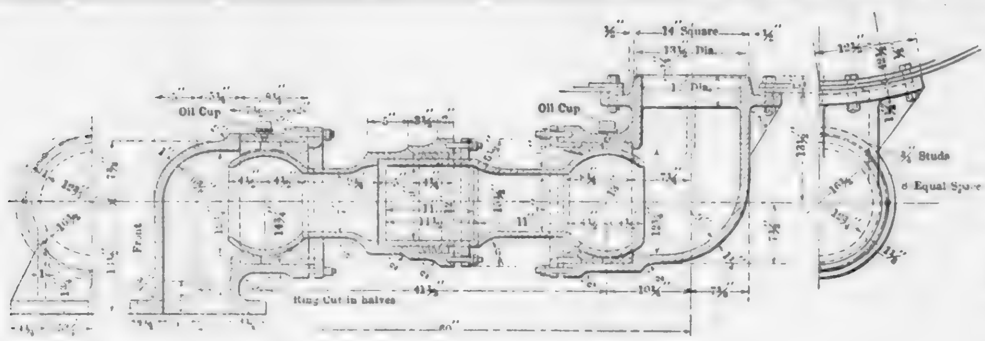


DETAILS OF RECEIVER PIPE.

The frames of both the front and rear section are of cast steel, 5 ins. wide and about 7 ins. deep at the pedestals. The two sections are connected together by a hinge joint, the details of which are shown in one of the illustrations. It will be seen from the general elevation that the center of this connection is equally distant from the center of the front axle of the rear engine and the rear axle of the front group. Connections are made from both the upper and lower rails of both sets of frames. The upper connection on the rear group is made in the saddle which supports the boiler at the high-pressure cylinders, but does not form part of the cylinder castings. It rests upon and between the upper rails of the frame, and is of the usual saddle appearance. A passage is cored longitudinally through its center, into which the radius bar from the front group reaches and hinges around a pin in the center. A similar connection on the lower frame is made by a heavy cast steel cross tie extending across and beneath the lower rails, and securely bolted thereto by five vertical and two horizontal bolts in each rail in addition to keys. The upper radius bar is of cast steel, with deep webs on the sides and in the center. It is fastened to a very rigid casting extending across and lipping over the top of the upper rails of the front frames, to which it is fastened by six vertical bolts in each rail. The radius bar fastens to this casting by both vertical and horizontal bolts, as shown in the illustration. The lower connection is made in a similar manner, with the exception that the space back of the pedestal is not wide enough to give a secure support for the cross tie, and an auxiliary casting has been fastened across the frames ahead of the ped-



DETAILS OF FRAME CONNECTION.



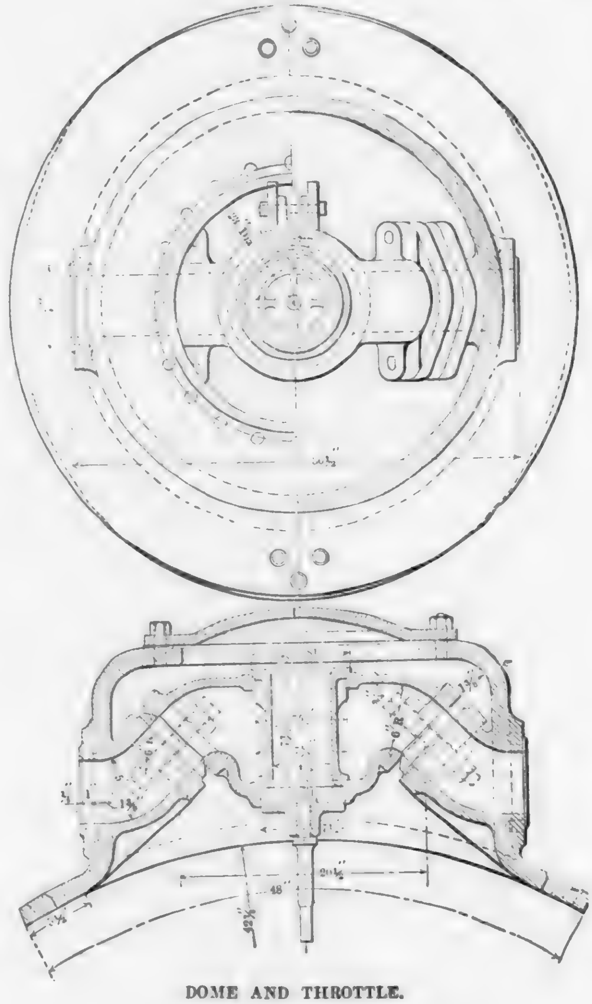
LOW-PRESSURE EXHAUST PIPE CONNECTION.

estal and extends backward, connecting to the cross tie. The hardened pins forming the hinge are 4 ins. in diameter and the holes are bushed.

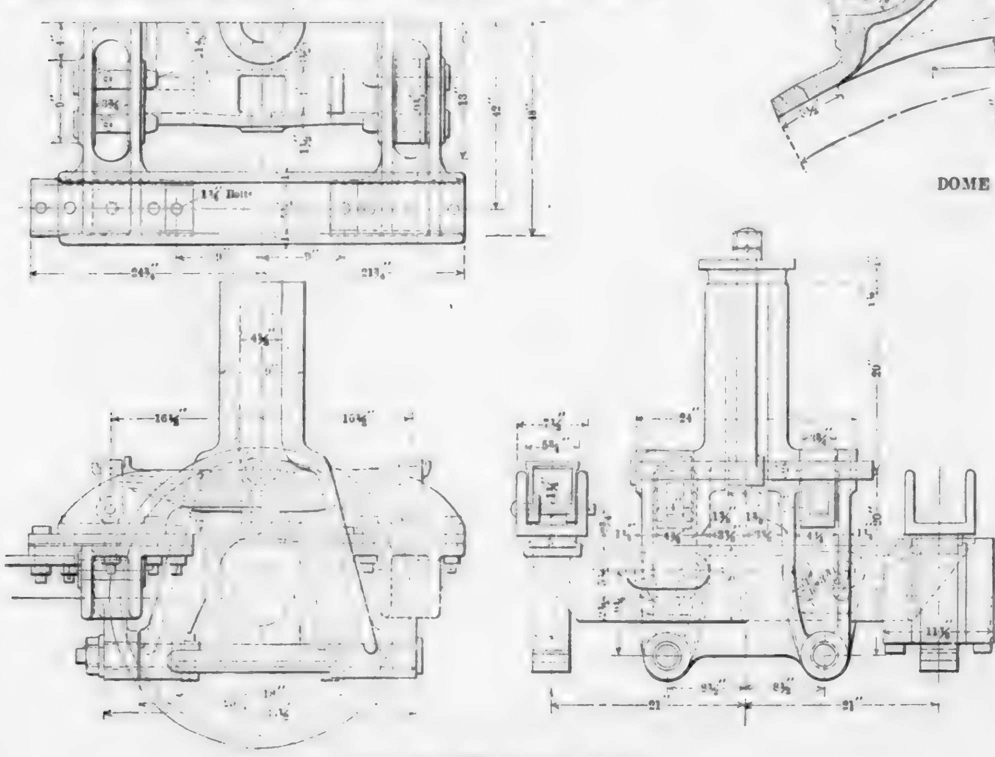
It will be noticed that the upper rails of the front group and the lower rails of the rear overlap each other, and that a vertical bolt joins these two projections. Since these frames will have a horizontal movement relative to each other, this bolt is provided with washers resting in balled seats in the frames, and the bolt itself has no side bearing in the frames. Its purpose is to equalize the weights at this point and prevent binding in the hinge or articulated connection.

The boiler is carried on the front set of frames by a support formed by a heavy steel casting across the upper rails of the frame between the two rear drivers and a saddle on the boiler shell which extends down and takes the bearing through a cast iron shoe. This bearing is designed to carry the whole weight of the front end of the boiler while still allowing free movement in the horizontal plane both for movement of the front group of wheels and expansion of the boiler. Just ahead of it is a spring centering device for bringing the front engine into line after leaving a curve, which will also help carry the weight of the boiler under unusual conditions. This consists of a casting across the upper rails of the frame, which also acts as a support for the guide yoke, and a radial saddle casting on the boiler shell. Two heavy coiled springs are arranged in the saddle, one on either side, and so connected to the casting on the frames that whenever the front group moves to one side the spring on that side will be put in compression.

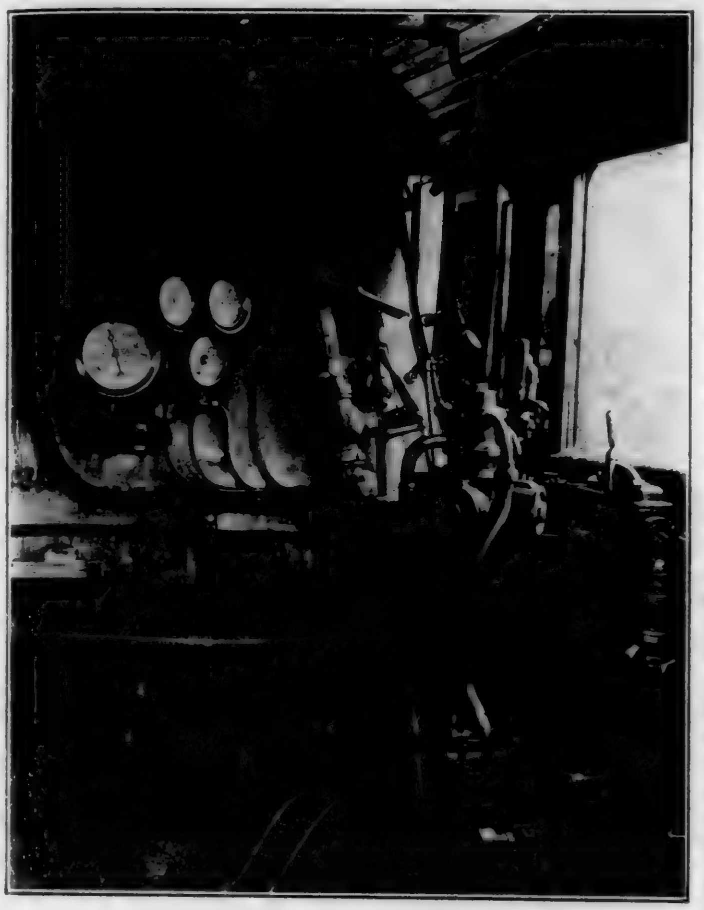
The high-pressure cylinders are cast without saddles, and are bolted and keyed to the upper and lower rails of the rear set of frames. The steam enters from the outside steam pipe, which connects just inside of the valve chest, and passes through cored passages to the valve. It exhausts from an opening on the inside, between the frames, into the receiver pipe, which extends forward between the frames to the low-pressure cylinders. This receiver pipe is shown in one of the illustrations, and it can be seen that it has a ball joint, whose center is in exact line with the center of the articulated connection. It is made up of five sections, the rear one being of cast steel and forming the ball joint; the two main sections are of heavy wrought iron pipe, with heavy flanges on each end for connecting to the adjoining sections; the fourth section forms the inner member of the slip joint and is of cast steel, while the fifth section is in the shape of a Y, forming the outside of the slip joint, and makes connections at the rear of the low-pressure cylinder saddle. The seats for the ball joint are of brass faced with babbitt, and between them is a space 1 in. wide which is packed with hemp. At the slip joint the packing is of white metal rings.



DOME AND THROTTLE.



SIDE BEARING RADIAL TRUCK.



VIEW IN CAB OF MALLET COMPOUND LOCOMOTIVE—GREAT NORTHERN RAILWAY.

The receiver pipe is supported at several points by angle-iron loops hung from the frame cross braces and by the vertical frame stiffening plate placed just back of the rear pedestals of the front group, through which it passes.

The low-pressure cylinders join at the center line of the engine, and the exhaust is carried to the front end by a pipe having a ball joint at either end and a slip joint in the center, the detail of which is shown herewith.

Special attention was given in the cylinder castings to separating the entering and the exhaust steam passages by an air space at all points. Balanced slide valves are used on both cylinders, both operated from the Walschaert type of valve gear. The receiver pipe is very heavily lagged, as is also the exhaust connection. The oil pipe connections to the low-pressure cylinders have several turns of large radius, making a flexible connection to allow for a considerable movement relative to the boiler. There is an auxiliary hand oil device on each low-pressure steam chest in case the oil pipes break.

There is no intercepting or reducing valve employed in this design, and the only starting device is a 1¼-in. pipe which connects into the receiver and has a valve in the cab, by means of which a small amount of high-pressure steam can be admitted to this pipe, principally for the purpose of preventing vacuum, although if left open long enough it will increase the pressure on the low-pressure pistons at slow speeds and in starting.

The front engine truck is of the usual radial design, with swing links and center bearing, but in the rear truck a special construction with side bearings has been used, which is shown in one of the illustrations. Reference to the general drawing will show that the two equalizers extending from the rear driving spring hangers are set diagonally inward and rest in the two swing links supported on a 2-in. pin passing through the pivot casting of the rear truck. This casting extends downward on either side of the axle with four legs, which connect to the lower end of four heart-shaped hangers. Each of these have their upper bearings on two pins in the cross ties of the truck frame. These cross ties connect the truck side frames of the pedestal type. The hangers of the elliptical spring over each journal box are fastened at these connections. The radius bar is connected to the truck frame.

It will be noticed that there is a bell crank on the boiler shell, just above the high-pressure cylinders, which forms part of the reversing mechanism of the valve gear. This crank is for the purpose of providing a hinge connection in the valve gear as near as possible to the articulated frame joint, so as to prevent the movement of the front group of wheels from distorting the movement of the valve. For clearance reasons it was necessary to make the connection to the radius bar of the rear valve motion ahead of the link, while that in front connects behind it. This difference in movement is equalized by the connection to the rear lift shaft, which gives the reach rod extending forward for the front valve gear a longer arm than that extending back into the cab.

The impossibility of handling two complete sets of very heavy valve gear with the ordinary reverse lever is easily understood, and for this purpose a type of power-reversing mechanism, which is known as the McCarroll, has been designed, and is shown in one of the illustrations. This device operates by air ordinarily, although a steam connection has been provided, and consists briefly of a rotary air engine driving a vertical shaft, which connects through beveled gears to a horizontal worm shaft. This worm operates a threaded

M'CARROLL REVERSING MECHANISM, MALLET COMPOUND LOCOMOTIVE—GREAT NORTHERN RY.

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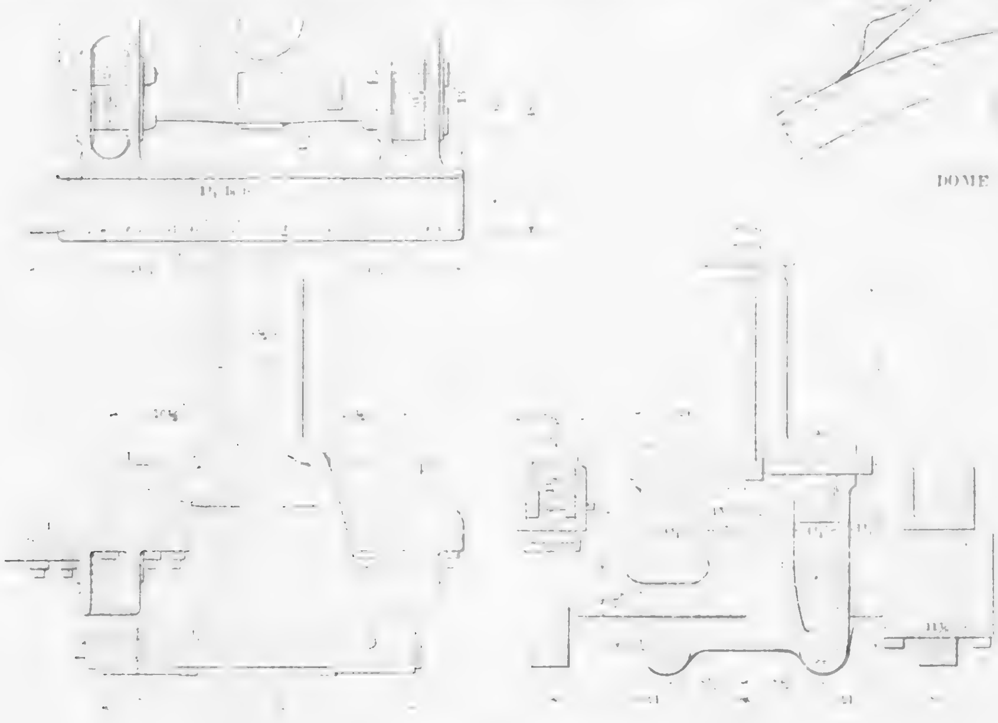

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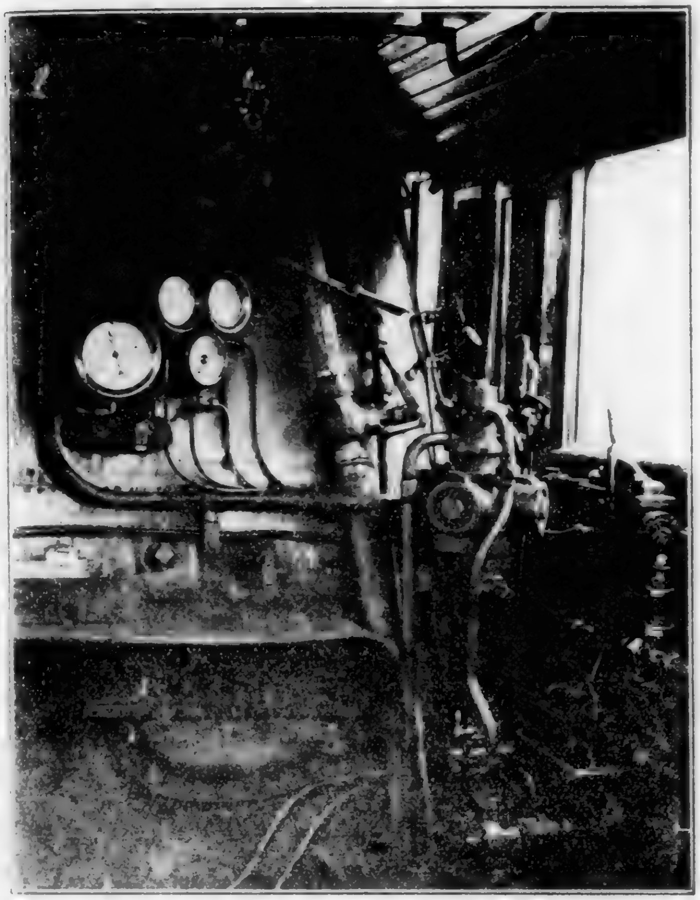

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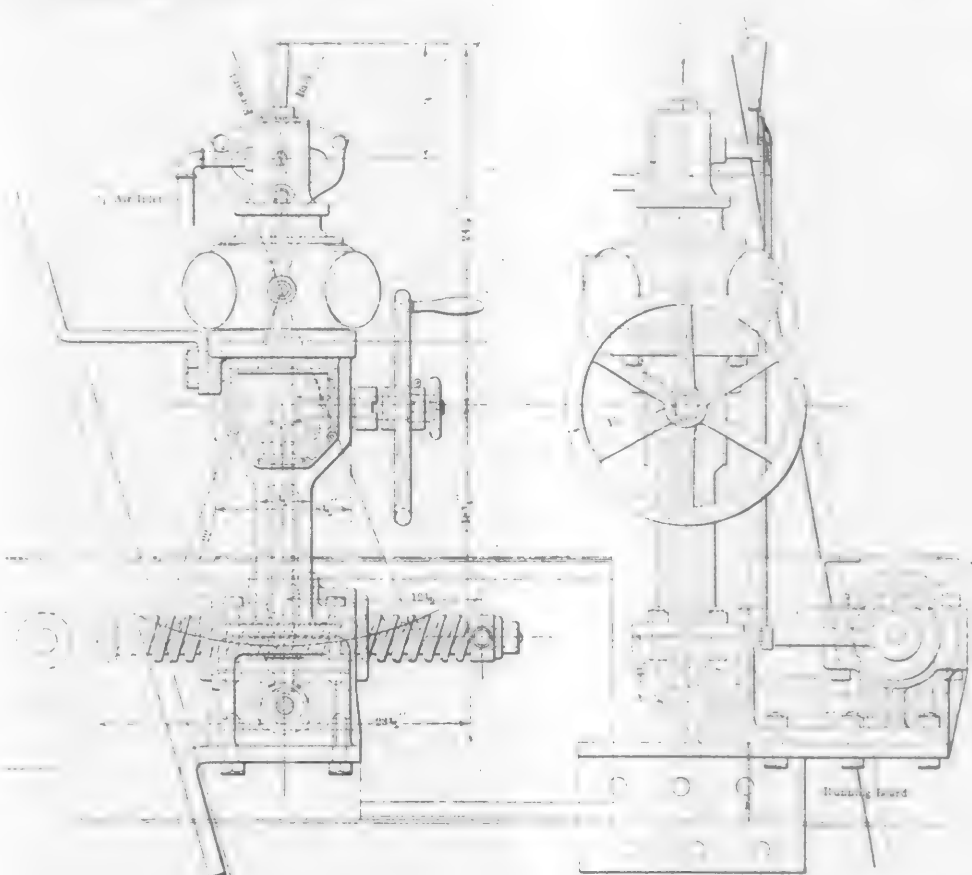


M'CARROLL REVERSING MECHANISM, MALLET COMPOUND LOCOMOTIVE—GREAT NORTHERN RY.

nut or bushing around the threaded end of the reach rod. The operation is controlled by a small handle, which moves a slide valve and admits air to operate the air engine in either direction. The handle is automatically brought to a closed position when the full gear point has been reached, and an indicator is provided which shows the position of the gear on a small quadrant. This gear is able to completely reverse the engine in three seconds. A hand wheel is provided for operating it in case of an emergency.

Two non-lifting injectors of extra large size are used.

The general dimensions, weights and ratios follow:

MALLET ARTICULATED COMPOUND LOCOMOTIVE.

GREAT NORTHERN RAILWAY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Freight
Fuel	Soft Coal
Tractive effort	71,600 lbs.
Weight in working order, est	355,000 lbs.
Weight on drivers, est	316,000 lbs.
Weight on leading truck, est	19,000 lbs.
Weight on trailing truck, est	20,000 lbs.
Weight of engine and tender in working order	503,000 lbs.
Wheel base, driving, each group	10 ft.
Wheel base, total	44 ft. 10 ins.
Wheel base, engine and tender	73 ft. 2¼ ins.

RATIOS.

Weight on drivers ÷ tractive effort	4.41
Total weight ÷ tractive effort	4.96
Tractive effort x diam. drivers ÷ heating surface	698
Total heating surface ÷ grate area	72.5
Firebox heating surface ÷ total heating surface per cent	3.9
Weight on drivers ÷ total heating surface	55.85
Total weight ÷ total heating surface	62.75
Volume equivalent simple cylinders	20.82 cu. ft.
Total heating surface ÷ vol. equivalent cylinders	271
Grate area ÷ vol. equivalent cylinders	3.75

CYLINDERS.

Kind	Compound
Diameter and stroke	21½ and 33 x 32
Valves	Balance slide

WHEELS.

Driving, diameter over tires	55 ins.
Driving, thickness of tires	3½ ins.
Driving journals, diameter and length	10 x 12 ins.
Front truck wheels, diameter	30 ins.
Front truck, journals	6 x 12 ins.
Trailing truck wheels, diameter	30 ins.
Trailing truck, journals	6 x 12 ins.

BOILER.

Style	Belpaire
Working pressure	200 ins.
Outside diameter of first ring	84 ins.
Firebox, length and width	117 x 96 ins.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	F. 6, S. & B. 5 ins.
Tubes, number and outside diameter	441-2¼ ins.
Tubes, length	21 ft.
Heating surface, tubes	5,433 sq. ft.
Heating surface, firebox	225 sq. ft.
Heating surafce, total	5,658 sq. ft.
Grate area	78 sq. ft.
Centre of boiler above rail	120 ins.

TENDER.

Tank	Water bottom
Frame	Steel
Wheels, diameter	36 ins.
Journals, diameter and length	5½ x 10 ins.
Water capacity	8,000 gals.
Coal capacity	13 tons

ERIE HOSPITAL CAR.—The Erie Railroad has recently added a 60-ft. hospital car to its equipment. The operating room is 15 ft. 10 ins. long and has a modern operating table and a full equipment of surgical instruments and supplies. Four-foot sliding doors on either side, with portable steps, permit an easy entrance with a stretcher. The room has six side windows, two windows in each door and a large window in the roof above the operating table. The inside finish is of composite board, made especiaally for this purpose, covered with white enamel paint. The floor is covered with white rubber tiling. The ward room, 43 ft. 4 ins. in length, is connected to the operating room by two sliding doors with ground glass windows. It is equipped with eleven brass beds, a lavatory and a saloon. The floor and inside finish is the same as that in the operating room, and white rubber curtains are used between the beds. Several ground glass windows, fitted with white rubber roller curtains, are provided on each side of the room. Supplies of all kinds are carried in equipment boxes underneath the car. Six-wheel trucks are used.

THE SURCHARGE PROBLEM.

BY C. J. MORRISON.

Every railroad is to a great extent a manufacturer, as various articles for locomotives, cars, stations, etc., are made in their shops. Great ignorance usually exists as to the actual cost of these articles. Some companies call the bare price of labor and material the cost, while others add an estimated surcharge ranging from 20 to 60 per cent. It is hardly fair to the railroad or to the outside manufacturers to compare these prices with the selling price of the same articles in the market. In some instances the railroad is losing money by buying articles which it should manufacture, while in others it loses by manufacturing articles which should be purchased. I believe, it is safe to say, that not over one railroad in the United States knows the exact surcharge in each department.

The surcharge may be divided into two distinct sections, first, the money surcharge, and second, the book surcharge. The money surcharge consists of the wages paid for supervision, accounting, drafting room, stationary engineers, firemen, electricians, etc. The book surcharge consists of taxes, interest on investment, depreciation of buildings and machinery, etc.

The surcharges in a modern railway repair shop will classify about as follows:

1. Rent.
   - A. Depreciation of Buildings—4 per cent. per annum.
   - B. Interest on Buildings—4 per cent. per annum.
   - C. Interest on Land—4 per cent. per annum.
   - D. Repairs to Buildings—Material and Labor.
   - E. Insurance.
   - F. Taxes.
2. Supervisory and Miscellaneous.
   - A. Superintendence and Office.
   - B. Accounting.
   - C. Drawing Room.
   - D. Spoiled Work.
   - E. Laborers and Watchmen.
3. Machinery.
   - A. Depreciation per annum 10 per cent.
   - B. Interest per annum 4 per cent.
   - C. Repairs (Labor).
   - D. Repairs (Material).
   - E. Replacing Small Tools.
   - F. High Speed and Other Steels.
   - G. Supplies.
4. Power, Heat, Light, Water, etc.
   - A. Depreciation per annum 4 per cent. } on Buildings.
   - B. Interest per annum 4 per cent. } on Buildings.
   - C. Depreciation per annum 10 per cent. } on Machinery.
   - D. Interest per annum 4 per cent. } on Machinery.
   - E. Wages.
   - F. Fuel.
   - G. Repairs.
   - H. Supplies.
   - I. Lamps, Coal Delivery, etc.

These items expressed as a percentage of the pay roll are found to average for a number of shops as follows:

	Loco. Dept.	Car Dept.	Total.
Rent	11.5	8.1	10
Supervision and Misc.	13.8	12.0	13
Machinery	26.6	14.4	21
Power	8.1	3.5	6
Total	60.0	38.0	50

The next step is to determine the surcharge for each department. It will not do to apply the flat 60 per cent. surcharge to any work in the locomotive department regardless of where it is performed. The surcharge on bench work and on machine work is entirely different. The surcharge for any department is found by determining the exact proportion of each charge which this department bears. These charges are found to vary in the different departments of one locomotive shop from 40 to 220 per cent.

We are now in a position to determine the exact cost of each article produced, and come to a logical conclusion as to whether we should buy or manufacture any given article. For example, suppose an article manufactured in the tin shop costs as follows:

Material	$0.85
Labor	1.25
Surcharge, 40 per cent	.50
Total	$2.60

We now know, beyond the shadow of a doubt, whether to buy or manufacture this article, as the decision hinges on whether the price is below or above $2.60.

In one shop where an exhaustive study of the surcharge

was made, articles which had formerly been manufactured are now purchased, while articles which had been purchased are now manufactured with a great saving to the company.

Another very important use that may be made of the surcharge study is to determine whether or not certain machines are profitable. In order to do this it is necessary to divide the surcharges into "machine charges" and "labor charges." The machines in the locomotive department will carry as much of charge 1 as they occupy buildings and grounds, probably half, about 10 per cent. of charge 2B, about 80 per cent. of charge 3, except 3E which goes on labor, and about 82 per cent. of charge 4. Probably the easiest and most practical way to handle this machine surcharge is as an hour rate on the machines. That is a machine will be rated at so much per hour just the same as a workman. To determine the rate on any machine, determine the total machine charge in the department in which the machine is located and express it as a per cent. of the total valuation of the machines, then determine the number of hours per year which the machine in question runs. Assume for example a machine whose valuation is $1,200 located in a department where the machine surcharge is 90 per cent. The machine must then earn 90 per cent. of $1,200 or $1,080 per year. Assume the machine runs 3,000 hours per year. It must then earn $0.36 per hour and that amount is its hour rate. The portion of the surcharge carried by the man will still be expressed as a per cent. of his wages, but will, of course, be much lower than in the case where the total surcharge is carried by the man.

A glance at the surcharge problem shows at once the importance of keeping the machines running, and of not doing work on a high-priced machine, which can be done in almost as short a time on a cheaper machine. It also shows that some classes of work may be done by hand cheaper than on a machine which will only run a few hours a year. A few months ago an energetic salesman offered for sale to a railroad a wonderful labor saving machine. It looked good, but, admitting it could do all the salesman claimed, it could not even earn its surcharge because it could not be kept busy. As an excellent example of this sort of thing take an old machine valued at $4,000 and whose hour rate is $0.70. A $3.00 man runs this machine and it requires three hours to complete a certain job. The cost is then:

Labor, 3 hours at $.30	$0.90
Labor surcharge, 90 per cent.	.81
Machine charge, 3 hours at $.70	2.10
Total	$3.81

Two of these machines are required to handle the work of the shop running 2,700 hours a year each. A machine advertised to do this work in 1 hour would cost, installed ready to run, $12,000. As this machine would run only 1,800 hours per year, its rate would be $3.00 per hour. The job would then cost:

Labor, 1 hour at $.30	$0.30
Labor surcharge, 90 per cent.	.27
Machine charge, 1 hour at $3.00	3.00
Total	$3.57

The savings on each job would therefore be $0.24 or $432 per year, which is 3.6 per cent. on the investment of $12,000. The investment would therefore be a good one as the machine, would not only pay its surcharges but also earn a profit of 3.6 per cent.

Another and very important question which comes up with the surcharge study is the problem of reducing costs. A careful study will show that in many cases costs may be greatly reduced by raising wages and demanding a greater output. Assume a man rated at $0.25 per hour running a machine whose rate is $0.60 per hour, and taking 5 hours to do a job. The cost is then:

Labor, 5 hours at $.25	$1.25
Labor surcharge, 60 per cent.	.75
Machine charge, 5 hours at $.60	3.00
Total	$5.00

Suppose the man's wages are raised to $0.30 per hour or another man is employed and the time for the job is reduced to 4½ hours. The cost is:

Labor, 4½ hours at $.30	$1.35
Surcharge, 60 per cent.	.81
Machine charge, 4½ hours at $.60	2.70
Total	$4.86

This change in time required, from 5 to 4½ hours, is not unusual. A cut of 50 per cent. in time on a job has often been effected by a 20 per cent. increase in wages.

The great mistake is often made of considering the pay roll, as the one great item which must be watched, and of paying no attention to the surcharges. This is a serious and sometimes a fatal mistake. The surcharges are just as real as the pay roll, and great savings may be effected by reducing the surcharges even if it is accomplished by raising wages. A cut in the surcharges never causes a strike or discourages the workmen.

THE ARTICULATED LOCOMOTIVE.—Heretofore the locomotive has grown generally in size and weight, without radical change in principle to meet conditions of growth which cannot properly be made through the application of the brute strength idea in design. Large freight locomotives of ordinary types now involve single parts so large as to be difficult to handle in the shop. Their very size gives evidence of the stresses to which they are subjected, and it is believed that the time has arrived for dividing the power and work of the freight locomotive into a larger number of parts, as is done in the case of the Mallet articulated compound, which has now been successfully running for over a year on the Baltimore & Ohio Railroad. This locomotive weighs 477,500 lbs., including tender, and is the heaviest and most powerful ever built. A glance at this enormous machine immediately indicates the absurdity of designing it upon the basis of two cylinders. This locomotive has operated so successfully as to practically establish the principle of the articulated compound for locomotives which are not nearly so heavy. This general subject of the large freight locomotive is one which now needs, and will continue to need, the attention of those who are preparing to deal with the problems of the next few years—*Mr. G. M. Basford, at Purdue University.*

COOLING AND VENTILATING THE NEW YORK SUBWAY.—The arrangements for cooling and ventilating the subway in New York City have been practically completed. At the Brooklyn Bridge Station the air will be cooled by water coming from four wells 45 ft. deep. The water is forced through two cooling coils, one on each side of the station, each consisting of 4½ miles of 1-in. pipe and capable together of cooling 150,000 cu. ft. of air 15 deg. a minute. Two fans are provided on each side of the station for driving the air over the coils and forcing it through large galvanized iron ducts of rectangular section, which run along the platforms. Square vents are cut at intervals. In addition to the plants which cool the air by the use of water pipes, ventilation will be secured by a system which will renew the air throughout the subway every 20 minutes. Ventilating holes will be cut in the roof at every station, the total area of these being 7,300 sq. ft. Thus far 680 sq. ft. of such openings have been provided. At a point midway between stations louvre valves will be installed, through which air will be forced out by the motion of trains. The total cost of the work now being done is $300,000.—*The Iron Age.*

TRAVELING ENGINEERS' ASSOCIATION.—The officers elected for the ensuing year are: President, W. J. Hurley, New York Central, Buffalo; first vice-president, A. M. Bickel, L. S. & M. S. Ry., Elkhart, Ind.; second vice-president, J. A. Talty, D., L. & W., Buffalo; third vice-president, Chas. F. Richardson, 'Frisco Line, St. Louis; secretary, W. O. Thompson, New York Central, Oswego, N. Y.; treasurer, C. B. Conger, International Correspondence Schools, Chicago. The 1907 convention will be held in Chicago.

SOUTH LOUISVILLE SHOPS.

LOUISVILLE & NASHVILLE RAILROAD.

II.

CAR DEPARTMENT.

The general plan and operation of these shops were considered on page 209 of our June, 1906, issue. They are located on a marshy piece of ground, and it was therefore necessary to support the concrete foundation walls and piers on creosoted piling driven through the sand and quicksand to gravel.

The buildings are all of very substantial construction. The style of architecture is plain, no attempt being made at decoration. The shop for the building of new freight cars, the freight car repair shop and the lumber shed are of steel construction, the side sheathing being of corrugated iron. The planing mill, the wheel and car material building, and the coach, paint and tender shop have red brick walls with steel frame work. Special attention was given to securing good daylighting in all of the buildings. The roofs are covered with a composition roofing material. Terra cotta and stone are used for coping, sills, etc. Circular ventilators are placed along the ridges of the roofs. All gutters and spouts are of copper. The interior steel work is painted gray.

LOOKING NORTH FROM SILL YARD—LUMBER SHED TO THE LEFT, PLANING MILL IN CENTER. FREIGHT CAR SHOP TO THE RIGHT.

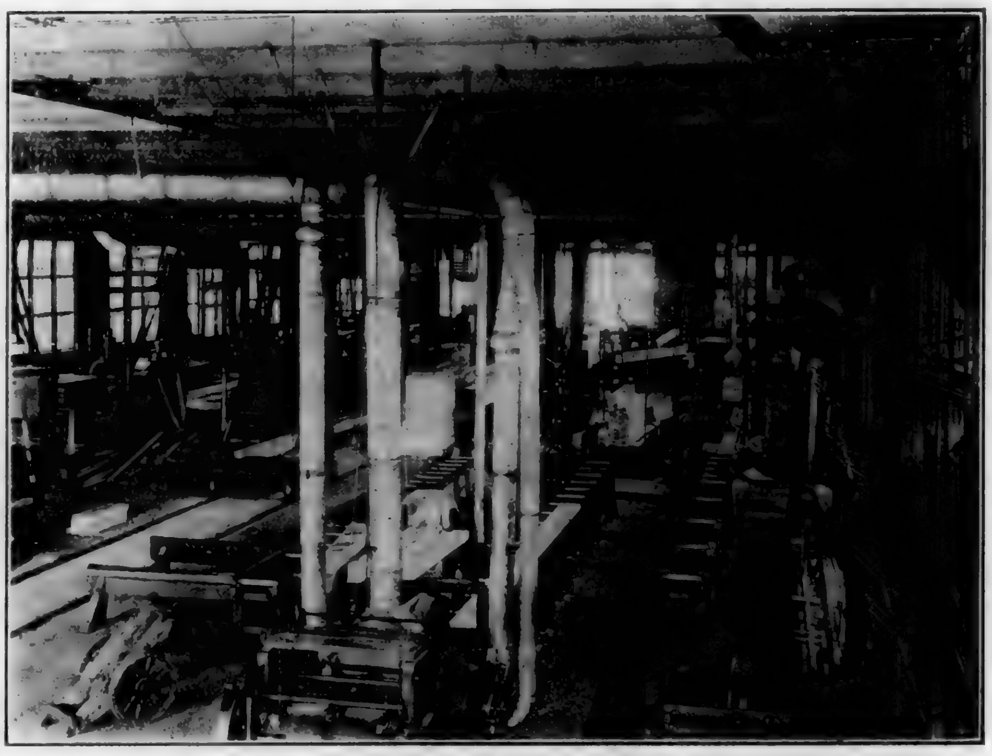
As stated in the first article, the buildings are very carefully arranged, so that the raw material enters at each end of the plant: wood at the south end and metal at the north end; and, as far as possible, travels with a minimum amount of handling and without doubling on its tracks until it reaches its objective point in the finished state. With this in mind, the buildings and equipment of the car department will, as far as possible, be described in the order in which the material is handled after it enters the plant.

The sills are stored in a space east of the dry kiln (see general plan, page 208); tracks lead directly from this space to the planing mill and transfer table. Other lumber is stored to the west of the dry kiln and lumber shed. The tracks in this yard are spaced 60 ft., center to center, and the lumber is handled on cars 2 ft. high, all platforms being built the same height, to facilitate loading and unloading.

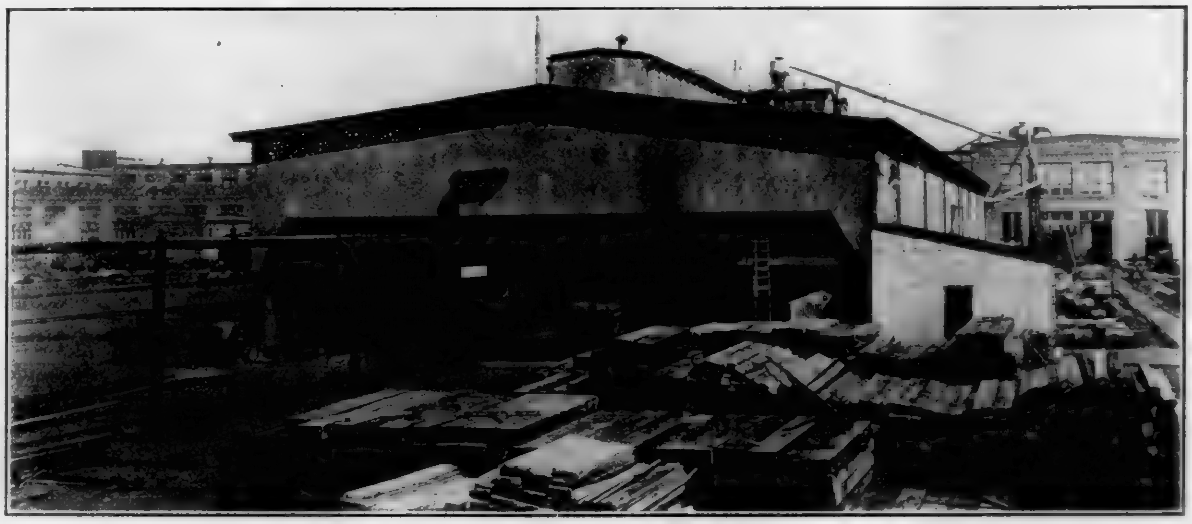
DRY KILN.

The dry kiln is a brick building, 65 x 104 ft., divided into three rooms, each 20 ft. wide, by longitudinal brick walls. It is equipped with the National patent moist air lumber dryer system, designed by the National Dry Kiln Company, Indianapolis, Ind. At each end are covered platforms, 24 ft. wide, one for receiving and the other for discharging the lumber. Alongside of these platforms are transfer tracks for the trucks which handle the lumber to and from the kiln. One of the illustrations shows the platform at the receiving end. The kiln has a holding capacity of 180,000 ft. of lumber. At the exhaust end of each section is a large flue which has eight openings into the drying room. These openings have independent dampers, and it is thus possible to closely regulate the temperature of the room. The steam headers in each room are also independent and equipped with regulating valves. The three rooms may therefore be operated at different temperatures, and it is thus possible to dry three different kinds of stock at the same time.

Each room contains two tracks of 6-ft. gauge. The rails, as well as the channels which carry the steam pipes, are supported on concrete piers. There is a double layer of heater pipes a little below the level of the rail which covers almost the entire floor area. Exhaust steam from the power house is used, although provision is made for using live steam, if necessary. The tracks and the heater pipes have an inclination of 3-16 of an inch to a foot. The walls of the building are of brick, with concrete foundations, and the roof trusses are of wood, ceiled on the underside (13 ft. 2 ins. from the top of rail) with two thick-



INTERIOR OF PLANING MILL.



LUMBER SHED.

RECEIVING PLATFORM OF DRY KILN.

nesses of T and G boarding ⅞ in. thick, with building paper between. The roof consists of ⅞ in. sheathing, covered with composition roofing.

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The lumber, after passing through the dry kiln, is stored in a lumber shed which lies 100 ft. to the north. This is a steel shed, 70 ft. wide by 260 ft. 7½ ins. long and about 25 ft. high at the eaves, and 35 ft. high over the clerestory. The sides are covered with galvanized corrugated iron to within 10 ft. of the ground, and the ends to within 16 ft. of the ground. During cold weather the open sides are boarded up. A composition roofing is laid on 1¾-in. sheathing nailed to 4x16-in. purlins, which are secured to the steel roof trusses by 2x⅜ in. iron straps. A clere-story, 10 ft. wide and about 6 ft. high, extends almost the entire length of the shed, and this, in connection with the open sides and ends, furnishes good daylighting. Two tracks extend through the shed and lead to the planing mill and transfer table. The lumber is stored on the cinder floor between the tracks and on a platform, or gallery, extending along one side of the shed. At the end of the shed nearest to the planing mill is a small group of machinery consisting of a cut-off saw, a light rip saw and a re-saw, and driven by a 60-h.p. Western Electric motor. This machinery is used very largely for manufacturing grain doors. The resaw is used for sizing lumber before it goes to the planing mill. The machines are connected to the shaving exhaust system in the planing mill.

PLANING MILL, SHOWING SHAVING EXHAUST PIPE EXTENDING TO THE ROOF OF THE POWER HOUSE.

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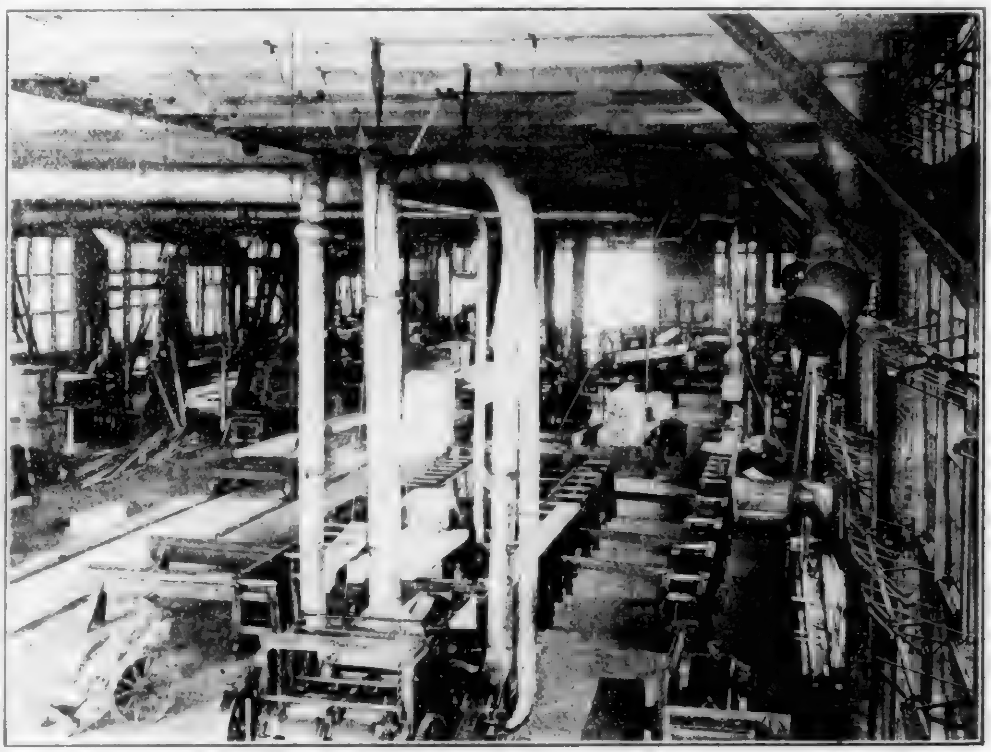
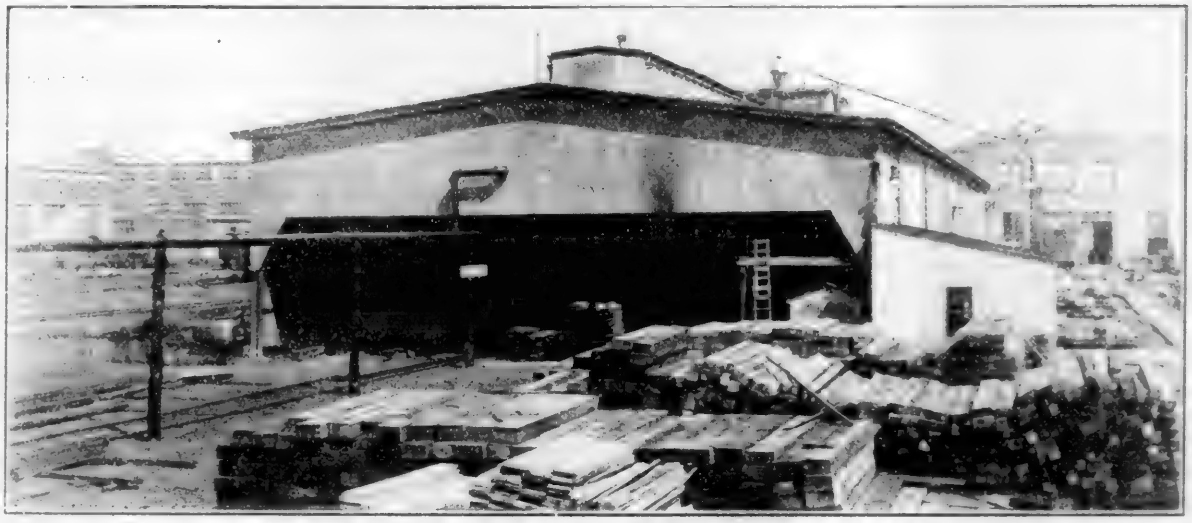


INTERIOR OF PLANING MILL



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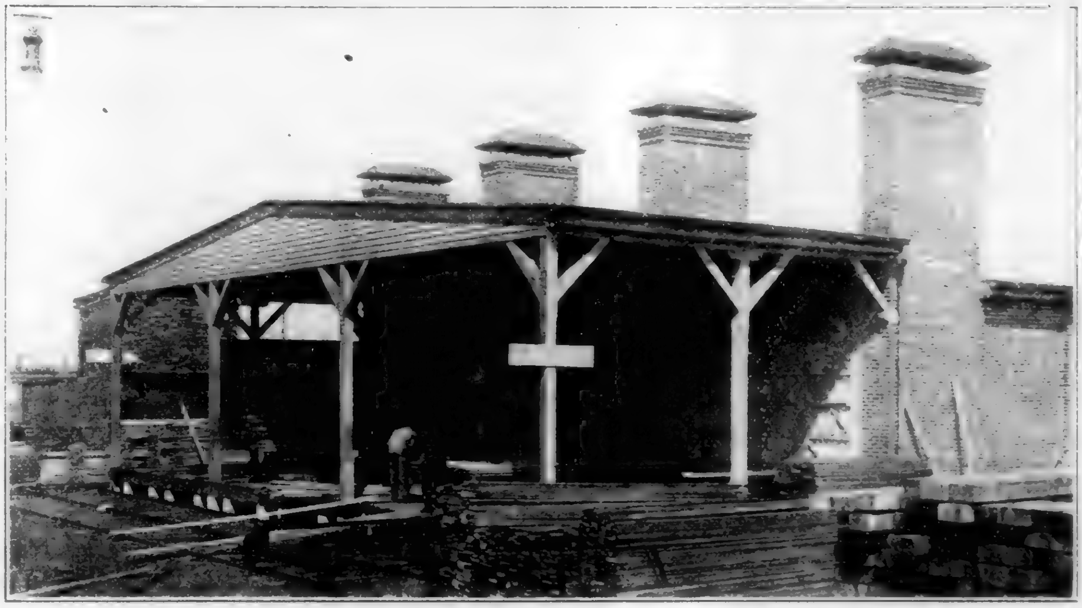
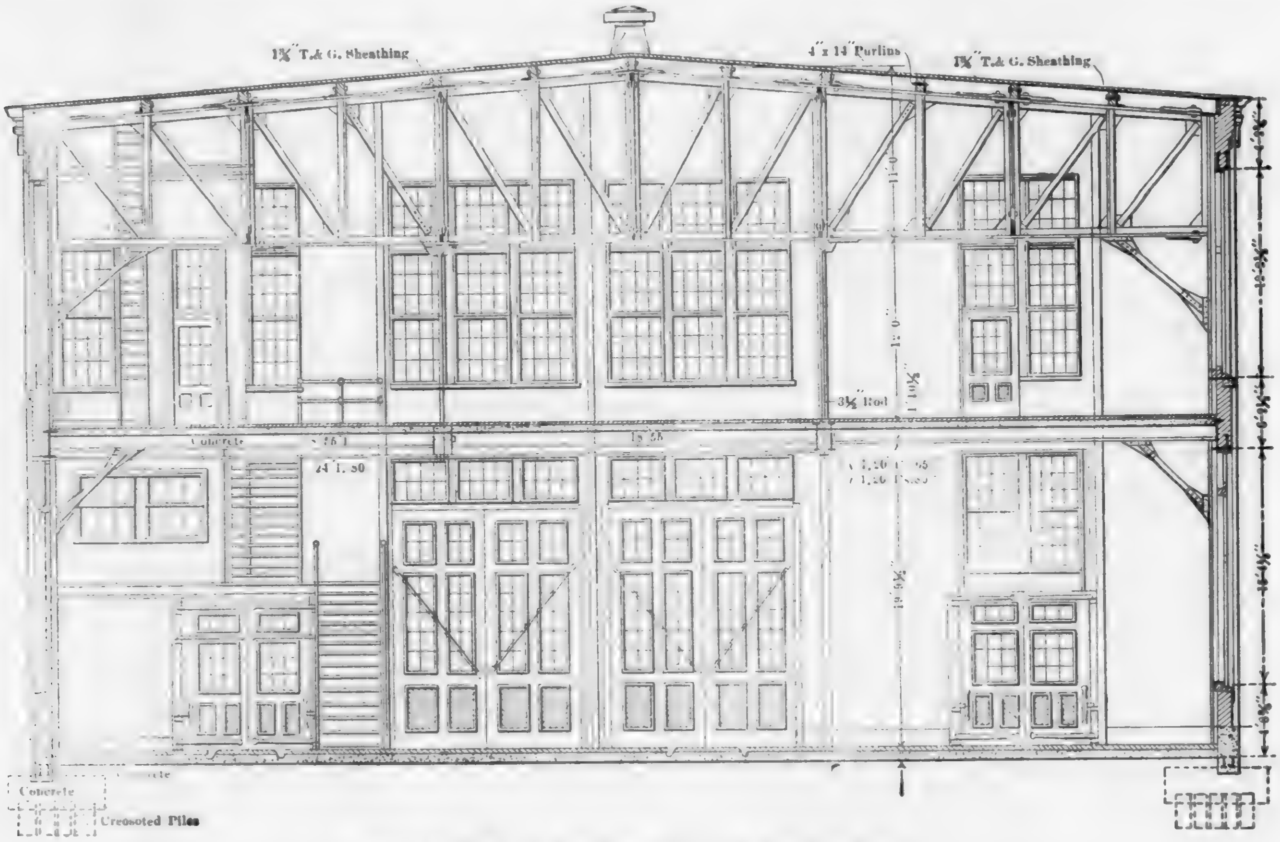
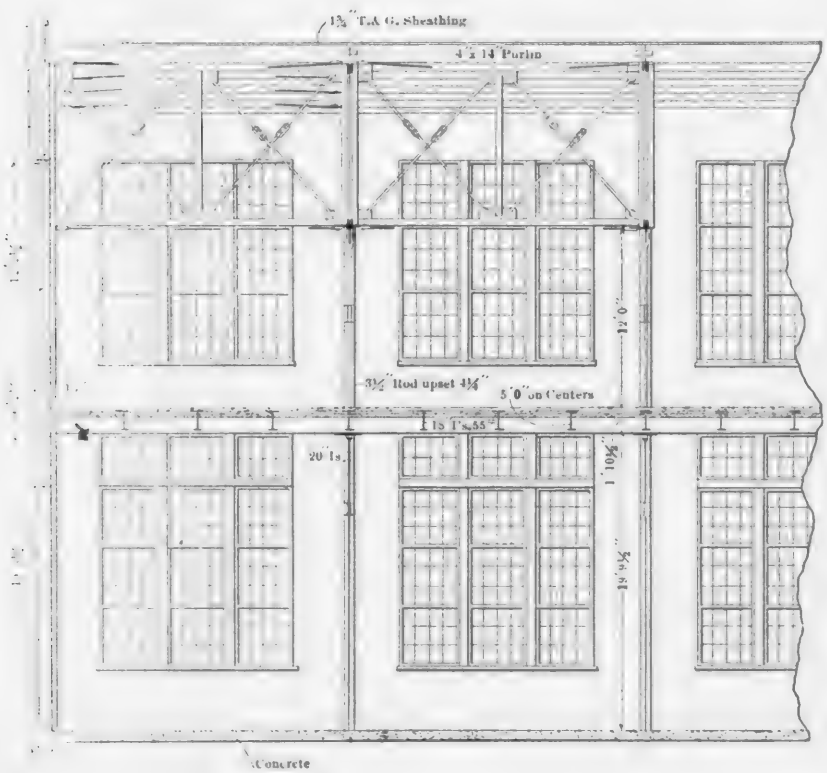


RECEIVING PLATFORM OF DRY KILN.

PLANING MILL, SHOWING SHAVING EXHAUST PIPE EXTENDING TO THE ROOF OF THE POWER HOUSE.



CROSS-SECTION OF PLANING MILL AND CABINET SHOP.

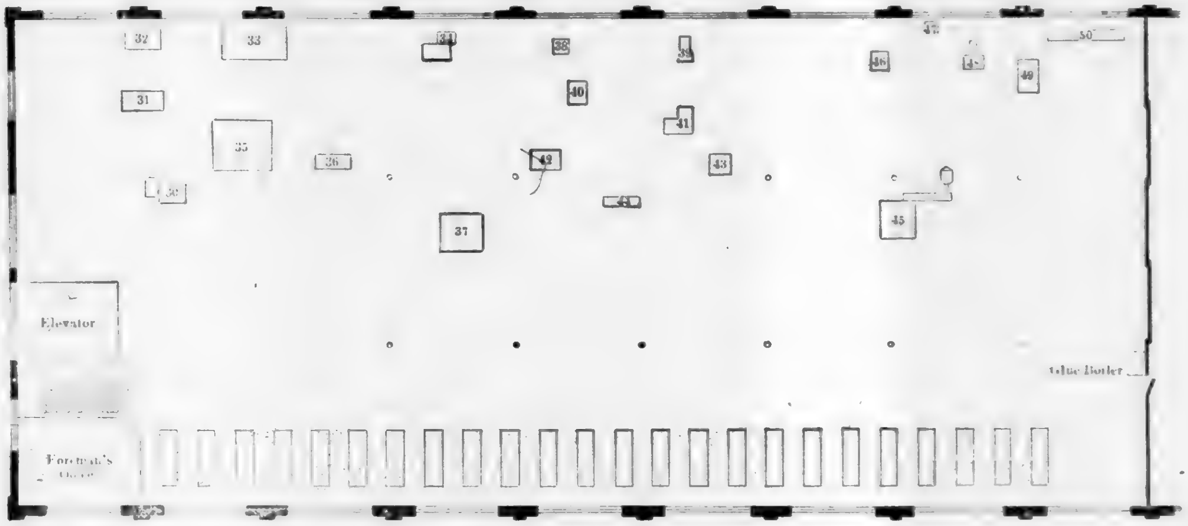


PART LONGITUDINAL SECTION OF PLANING MILL AND CABINET SHOP.

PLANING MILL.

The planing mill is a two-story steel frame brick building, 80 x 562 ft., with the cabinet shop on the second floor. It faces the transfer table and lies between the coach shop and the new freight car shop. If necessary, the building may be extended 100 ft. to the south, as shown on the general plan, page 208. An interesting feature in the design of the building is that no columns are used for supporting the second floor, but it is carried entirely by wall connections and by suspension rods from the roof trusses. A line of 20-in. I beams is built into the inner face of each side wall, a little below the level of the second floor, as shown in the sectional view of the building. Two pairs of 20-in. I beams are supported by 3½-in. rods, which are upset to 4¼ ins. at the lower ends to take nuts, and are connected to the roof trusses at the upper ends by pins. These beams divide the width of the building into three parts, and between the beams are framed 18-in. I beams placed transversely, 5 ft. center to center. Upon this steel framing is laid a concrete floor, with a granitoid wearing surface, designed for a load of 250 lbs. per sq. ft. The main floor is also of concrete, with a granitoid wearing surface. The roof is carried by 4 x 14-in. purlins supported on the steel roof trusses, and consists of 1¾-in. sheathing covered with a composition roofing.

A study of the arrangement of the machinery will show that the rough material is intended to enter the planing mill at the south end and comes out at the north end to the transfer table in a finished state. Material is conveyed to the cabinet shop by a 5-ton elevator at the north end of the building, operated by a 25-h.p. motor. A track extends from the transfer table to the elevator platform. There is also a stairway at each end of the building. The large machines are all connected to a shaving exhaust system. Three exhaust blowers discharge the shavings into bins on top of the building and they are transferred from these to the power house by another blower. The arrangement of the exhaust pipes in connection with one of the short sill dressers is clearly shown on the interior view of the planing mill, and the arrangement of the storage



ARRANGEMENT OF TOOLS IN THE CABINET SHOP.

pockets on top of the building and the piping from them to the power house is shown on several of the illustrations. The larger tools are driven by individual motors, while the smaller ones are arranged in groups. Following are lists of the machine tools and motors in the planing mill and cabinet shop, with numbers corresponding to those on the diagrams, showing the arrangement of the machinery in these two shops.

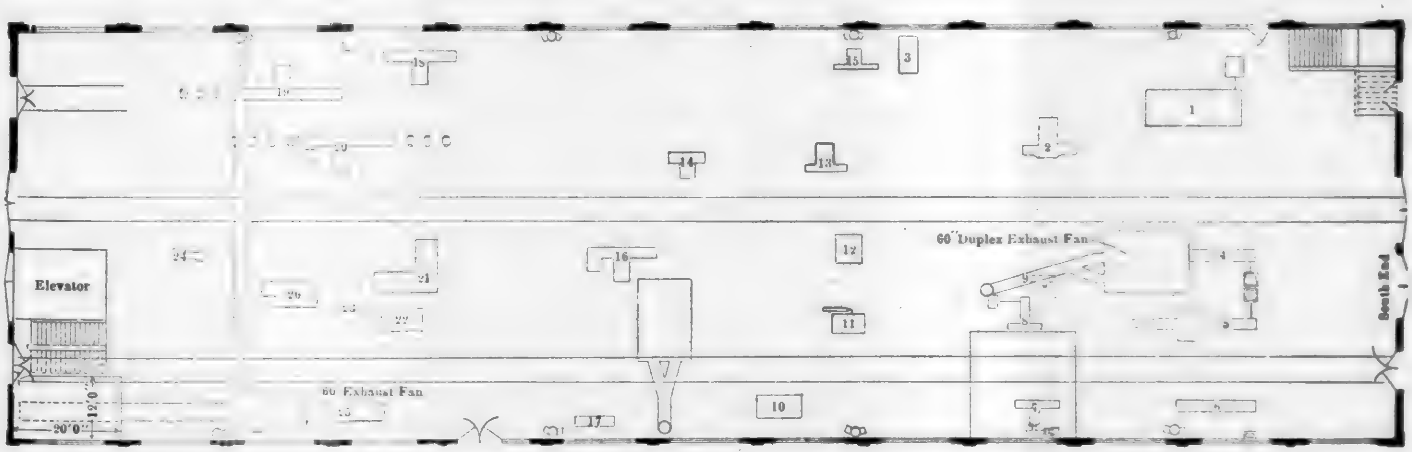
PLANING SHOP TOOLS.

No.	Name.	Motor.
30	Carriage cut-off saw, No. 2, Fay & Egan	
31	Rip saw, Bental & Margedant Co.	
32	Rip saw, Bentel & Margedant Co.	
33	Planer and matcher, No. 8, Fay & Egan	
34	Tenoning machine, No. 2, Fay & Egan	W. E., 30 h.p.
35	Combination universal woodworker and moulder No. 3, Fay & Egan	
36	4-side 4-in. moulder, No. 1½, Fay & Egan	
37	Pony planer, 24-in. blade, Goodell & Waters Co.	
38	Mortiser, No. 71, Fay & Egan	
39	Vertical double spindle boring machine, No. 2, Fay & Egan	
40	Double spindle shaper, No. 2½, Fay & Egan	
41	Mortiser and relisher, No. 93, Fay & Egan	Bullock, 14 h.p.
42	Combination saw and dado, No. 5, Fay & Egan	
43	Single head shaper, Fay & Egan	
44	Grindstone, L. & N. R. R.	
45	Sand papering machine, No. 4, Fay & Egan	Bullock, 18 h.p.
46	Combination panel carver and friezer, No. 4, Fay & Egan	
47	Plug cutter, Egan Co.	
48	Scroll saw, Fay & Egan Co.	Bullock, 8 h.p.
49	Marquit veneer saw, L. & N. R. R.	
50	22-in. x 12-ft. lathe, Putnam Mach. Co.	

PLANING MILL TOOLS.

No.	Name.	Motor.
1	Short sill dresser, 20-in. blade, S. A. Woods Mach. Co.	Willey, 100 h.p.
2	Cut-off saw, 40-in., Greenlee Bros. & Co.	Bullock, 15 h.p.
3	Cut-off saw, 40-in., Greenlee Bros. & Co.	
4	Matcher, 15-in. blade, Fay & Egan	W. E., 30 h.p.
5	Matcher, 10¼-in. blade, Fay & Egan	W. E., 50 h.p.
6	Matcher, 10¼-in. blade, Fay & Egan	W. E., 30 h.p.
7	Cut-off saw, 34-in., Egan Co.	Bullock, 8 h.p.
8	Cut-off saw, 34-in., Egan Co.	Bullock, 14 h.p.
9	Cut-off saw, 32-in., J. A. Fay & Co.	W. E., 30 h.p.
10	Surfacer, 26-in. blade, Fay & Egan	
11	Heavy rip saw, 28-in., No. 153, S. A. Woods Co.	
12	Light rip saw, 28-in., Greenlee Bros. & Co.	
13	5-spindle borer, Greenlee Bros. & Co.	W. E., 30 h.p.
14	Vertical hollow chisel mortiser, No. 154, Fay & Egan	
15	Sill tenoner, 3 cutters, Fay & Egan	W. E., 30 h.p.
16	Gainer, Greenlee Bros. & Co.	Bullock, 14 h.p.
17	Swing cut-off saw, 24-in., L. & N. R. R.	Bullock, 5 h.p.
18	5-spindle borer, Fay & Egan	
19	Vertical hollow chisel mortiser with traveling table, No. 154, Fay & Egan	Bullock, 18 h.p.
20	Automatic car gainer, No. 150, Fay & Egan	Bullock, 18 h.p.
21	Universal car tenoner, Fay & Egan	
22	Horizontal borer, Fay & Egan	
23	Vertical single spindle borer, Bental & Margedant	W. E., 50 h.p.
24	Band saw, No. 2, Fay & Egan	
25	Dimension planer, 24-in. blade, Fay & Egan	
26	Universal wood-worker, Fay & Egan	Bullock, 8 h.p.

The cabinet shop is, as far as possible, so arranged that the work coming from the elevator passes along one side of the shop and returns along the other side. The bench work is done along the western side. The open space between the benches and the machines is used for the erection of locomotive cabs and the storage of material. One end of the shop is fitted up as a tool room for sharpening and repairng saws and tools, and has a very complete equipment for carrying on this work. The building is heated by a hot-air system, the blowers being driven by electric motors, and exhaust steam from the power house being used to heat the air.



ARRANGEMENT OF TOOLS IN THE PLANING MILL.

COACH, PAINT AND TENDER SHOP.

Just west of the planing mill, and directly across the transfer pit from the locomotive shop, is a building, 180 x 482 ft., which is divided by three brick fire walls, which extend above the roof, into four divisions. The openings in the fire walls are fitted with automatic sliding fire doors. The division on the east end, or nearest the planing mill, is divided into a

VIEW OF COACH SHOP, FROM THE ROOF OF THE LOCOMOTIVE SHOP.

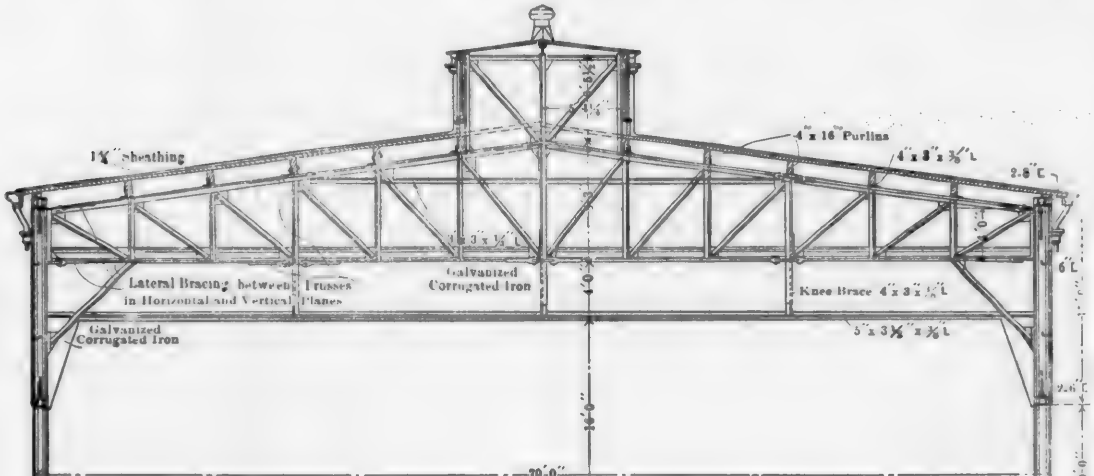
room, 59½ ft. x 87 ft. 11½ ins., which is devoted to work on passenger trucks, and into a store and brass finishing room, and above the latter two is an upholstering room and a wash-room. The next division is 218 ft. 11 ins. x 178 ft. It is devoted entirely to coach work and has eleven tracks, spaced 20 ft., center to center, each one of which will hold two coaches. The third division, 118 ft. 11 ins. wide, is used as a coach paint shop and has six tracks running through it, each one of which will hold two coaches. The tender shop at the west end is 79 ft. 5 ins. wide and is equipped with a shallow pit transfer table, driven by an electric motor, as shown on the drawing. It has a capacity for fifteen tenders. The tracks just south of the shop are used for storing tenders.

The construction of the building is clearly shown by the sectional views. The daylighting is splendid, due to the very large amount of window space in the side and end walls and to the saw-tooth roof construction. The saw-tooth frames are carried by the parallel cord trusses, spaced 20 ft., center to center, which are supported by the wall columns and a central row of columns. A composition roof is laid on 1¾-in. sheathing. The floor is of concrete with a granitoid finish. The large doors are arranged to slide upward instead of swinging inward.

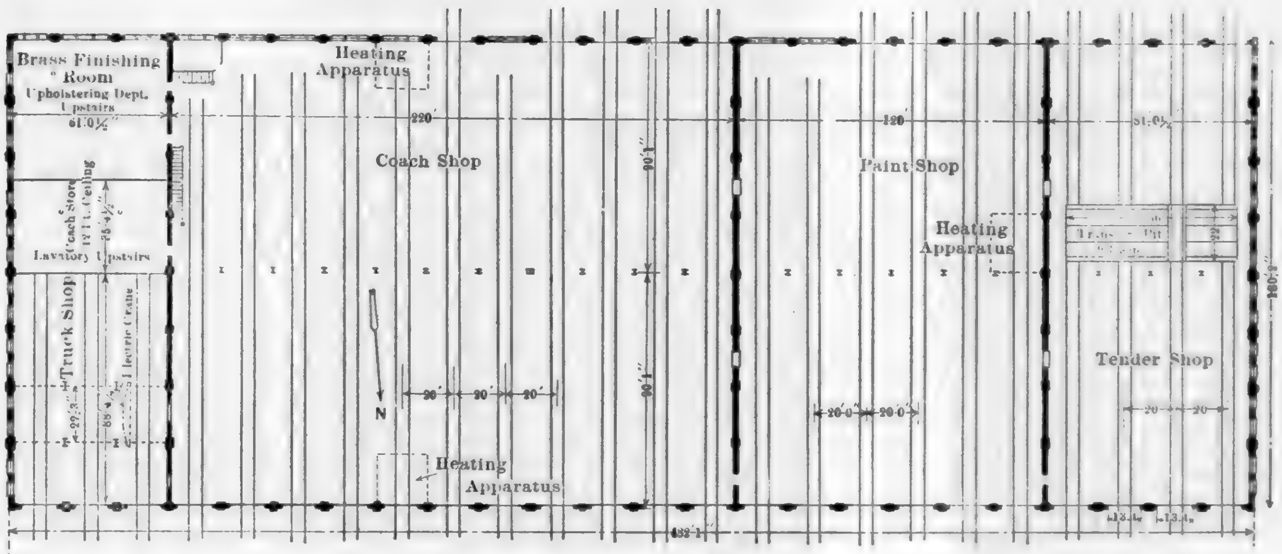
If the transfer table should, for any reason, be temporarily put out of service, several of the tracks in the coach, paint and tender shop extend through the shop at the south end and connect with the yard tracks, and coaches and tenders could, if necessary, be removed over these tracks. A short distance south of the paint shop is a small brick building, 32 ft. 10 ins. x 52 ft. 10 ins., which is used for the storage of paints and oils. The foundations are of concrete and the floor is of reinforced concrete, with a granitoid wearing surface. The roof is of Book tile, covered with composition roofing material, and is supported by steel trusses. The passenger truck shop is equipped with a 10-ton electric crane. The wash-room is equipped with expanded metal lockers. The entire building is heated by hot air, the fans and heating apparatus being supported on platforms placed above the roof trusses and arranged as shown in the plan.

NEW FREIGHT CAR SHOP.

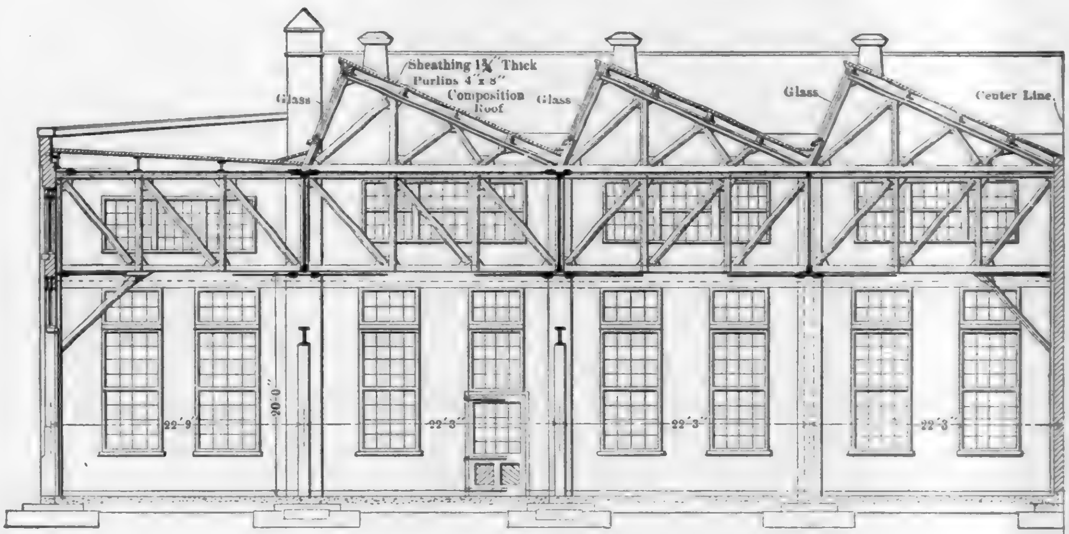
The shop for building new freight cars lies east of the planing mill and is 300 ft. 7⅝ ins. long and 134 ft. 8 ins. wide. Provision is made for an extension 200 ft. to the south, if necessary. The building is entirely of steel construction, as shown by the accompanying views. The columns supporting the roof trusses divide it into three parts, each part containing two tracks for the building of cars, with a material track of standard gauge between them. The six building tracks have a capacity for 42 cars. The ends of the building are covered with corrugated galvanized iron to within 16 ft. 9 ins. of the ground, and the sides are of the same material to within 10 ft.



CROSS-SECTION OF LUMBER SHED.

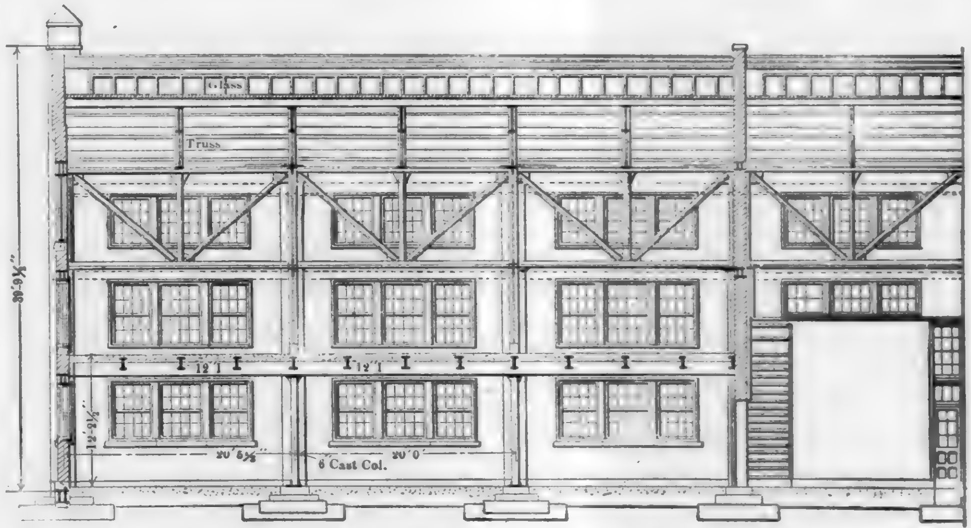


PLAN OF COACH, PAINT AND TENDER SHOP.



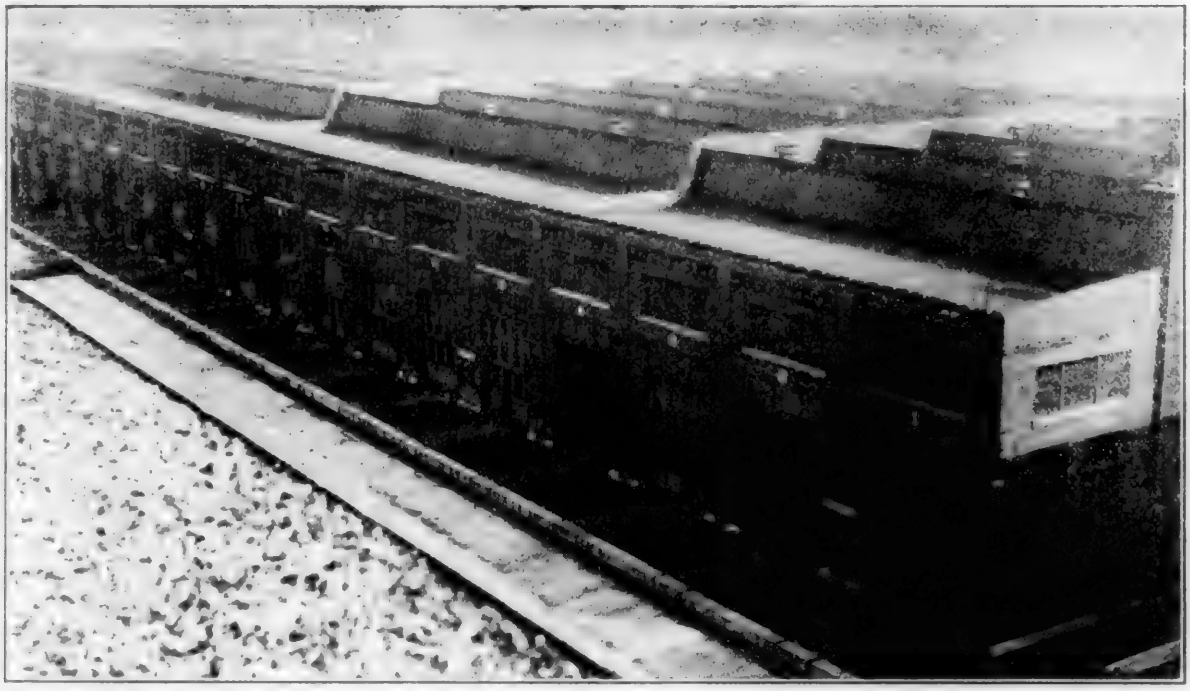
HALF CROSS-SECTION OF COACH, PAINT AND TENDER SHOP.

of the ground. Both the sides and ends of the building are equipped with rolling steel doors. Extending over the middle of the center bay for its entire length is a monitor, or clere-story, fitted with skylights. There are also a series of monitors fitted with skylights extending over the middle of each side bay. A large area of stationary sash also extends along each side of the building above the corrugated iron sheathing. The scaffolding, or suspended platforms, alongside the building tracks are of permanent construction. The platforms are about 4 ft. wide and are supported about 7 ft. above the floor by angles hung from the roof trusses. Extensions on either side of the platforms, 2 ft. 6 ins. wide, are hinged to them so that they may be folded over out of the way when not in use. The photograph shows them folded back, while the drawing shows them extended for use. They are held in a horizontal position by ¼-in. wire rope cables which are fastened to the roof trusses. A composition roofing is used and the floor is of concrete, with a granitoid finish.



PART LONGITUDINAL SECTION OF COACH SHOP AT EASTERN END.

The timber is transferred from the planing mill, either over the transfer table or the lighter timber is handled directly from the mill on push-cars. The trucks and such other stores as are kept in the car material building, which lies between the blacksmith shop and the foundry, are placed by the traveling crane on the transfer table and are then pushed directly into the shop. Considerable material, such as bolts, is stored underneath the platforms at the sides of the building, and surplus material, such as large castings and finished lumber, is stored between the tracks, just south of the shop. Ordinarily, three of the tracks in the shop are used for erection purposes while material is being brought in and placed alongside of the other three. If necessary, however, all six tracks may be used for erecting purposes at the same time, and the material can be placed during the



VIEW OF COACH SHOP, FROM THE ROOF OF THE LOCOMOTIVE SHOP.

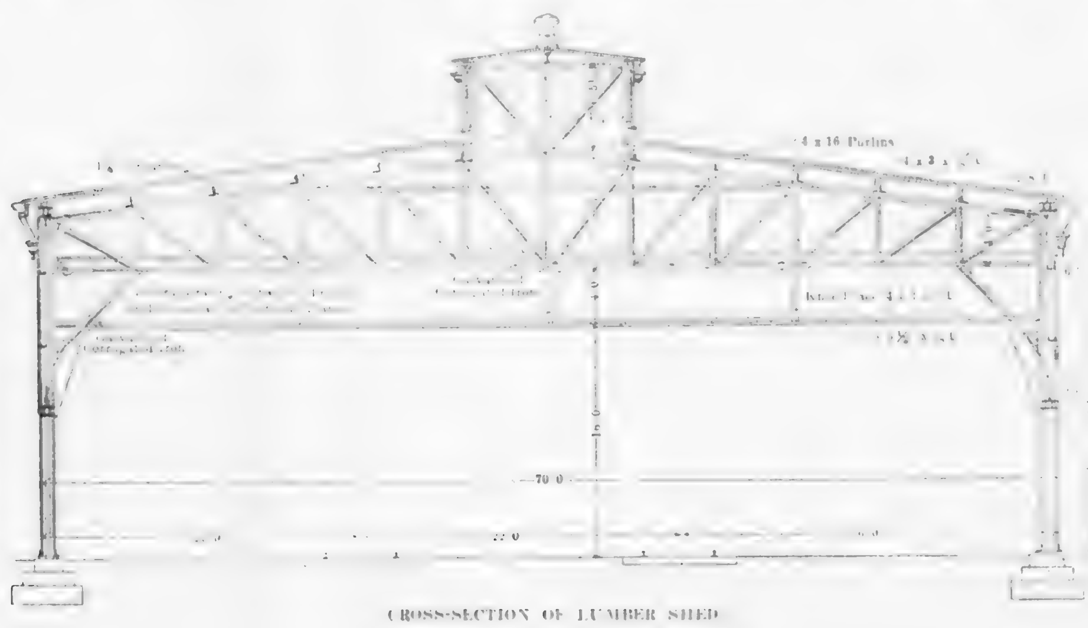
room, 59½ ft. x 87 ft. 11½ ins., which is devoted to work on passenger trucks, and into a store and brass finishing room, and above the latter two is an upholstering room and a wash-room. The next division is 218 ft. 11 ins. x 178 ft. It is devoted entirely to coach work and has eleven tracks, spaced 20 ft., center to center, each one of which will hold two coaches. The third division, 118 ft. 11 ins. wide, is used as a coach paint shop and has six tracks running through it, each one of which will hold two coaches. The tender shop at the west end is 79 ft. 5 ins. wide and is equipped with a shallow pit transfer table, driven by an electric motor, as shown on the drawing. It has a capacity for fifteen tenders. The tracks just south of the shop are used for storing tenders.

The construction of the building is clearly shown by the sectional views. The daylighting is splendid, due to the very large amount of window space in the side and end walls and to the saw-tooth roof construction. The saw-tooth frames are carried by the parallel cord trusses, spaced 20 ft., center to center, which are supported by the wall columns and a central row of columns. A composition roof is laid on 1¾-in. sheathing. The floor is of concrete with a granitoid finish. The large doors are arranged to slide upward instead of swinging inward.

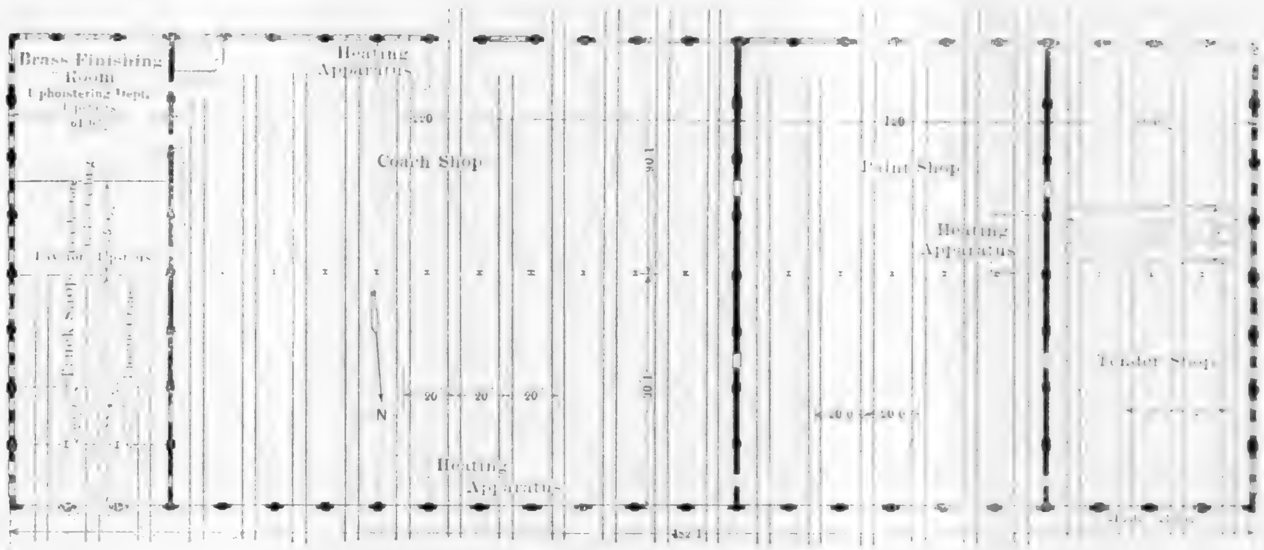
If the transfer table should, for any reason, be temporarily put out of service, several of the tracks in the coach, paint and tender shop extend through the shop at the south end and connect with the yard tracks, and coaches and tenders could, if necessary, be removed over these tracks. A short distance south of the paint shop is a small brick building, 32 ft. 10 ins. x 52 ft. 10 ins., which is used for the storage of paints and oils. The foundations are of concrete and the floor is of reinforced concrete, with a granitoid wearing surface. The roof is of Book tile, covered with composition roofing material, and is supported by steel trusses. The passenger truck shop is equipped with a 10-ton electric crane. The wash-room is equipped with expanded metal lockers. The entire building is heated by hot air, the fans and heating apparatus being supported on platforms placed above the roof trusses and arranged as shown in the plan.

NEW FREIGHT CAR SHOP.

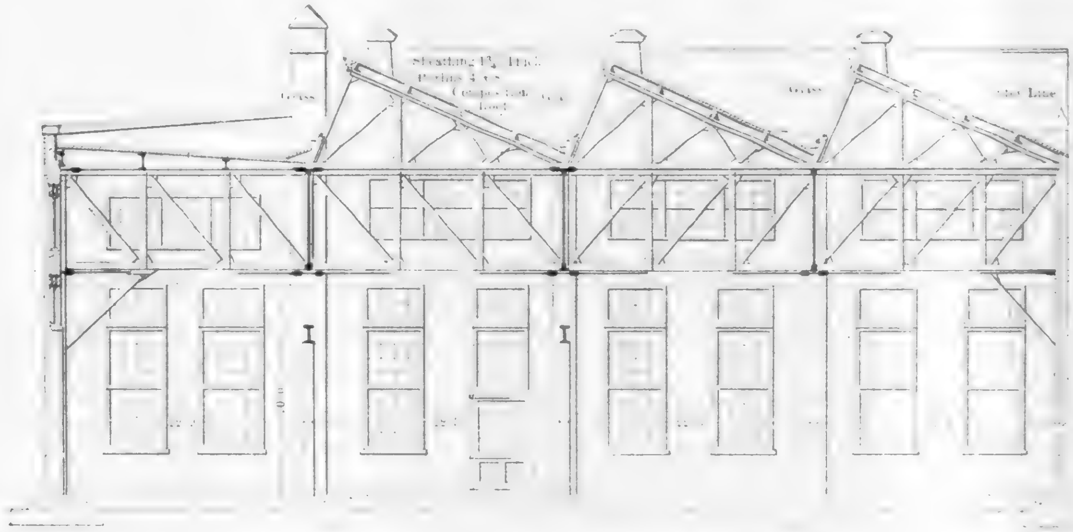
The shop for building new freight cars lies east of the planing mill and is 300 ft. 7¾ ins. long and 134 ft. 8 ins. wide. Provision is made for an extension 200 ft. to the south, if necessary. The building is entirely of steel construction, as shown by the accompanying views. The columns supporting the roof trusses divide it into three parts, each part containing two tracks for the building of cars, with a material track of standard gauge between them. The six building tracks have a capacity for 42 cars. The ends of the building are covered with corrugated galvanized iron to within 16 ft. 9 ins. of the ground, and the sides are of the same material to within 10 ft.



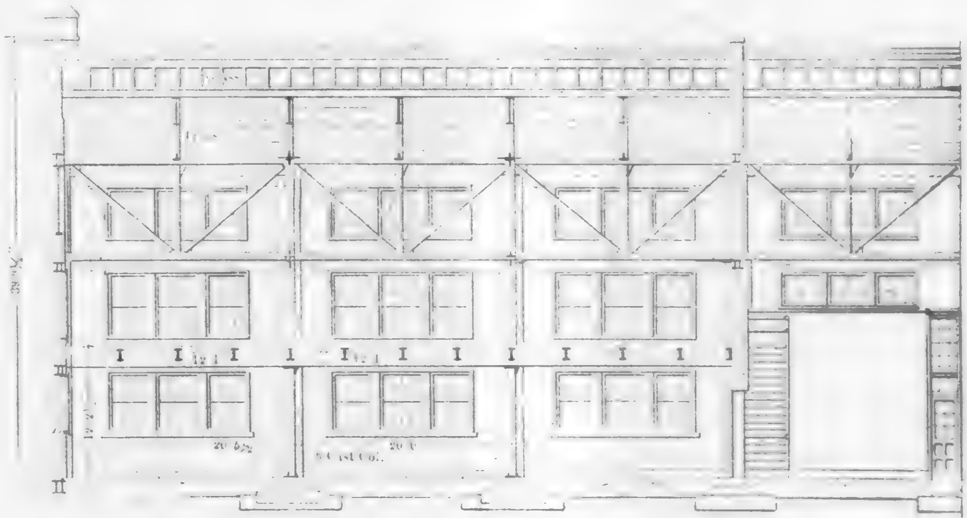
CROSS-SECTION OF LUMBER SHED



PLAN OF COACH, PAINT AND TENDER SHOP.



HALF CROSS-SECTION OF COACH, PAINT AND TENDER SHOP.



PART LONGITUDINAL SECTION OF COACH SHOP AT EASTERN END.

of the ground. Both the sides and ends of the building are equipped with rolling steel doors. Extending over the middle of the center bay for its entire length is a monitor, or clere-story, fitted with skylights. There are also a series of monitors fitted with skylights extending over the middle of each side bay. A large area of stationary sash also extends along each side of the building above the corrugated iron sheathing. The scaffolding, or suspended platforms, alongside the building tracks are of permanent construction. The platforms are about 4 ft. wide and are supported about 7 ft. above the floor by angles hung from the roof trusses. Extensions on either side of the platforms, 2 ft. 6 ins. wide, are hinged to them so that they may be folded over out of the way when not in use. The photograph shows them folded back, while the drawing shows them extended for use. They are held in a horizontal position by ¼-in. wire rope cables which are fastened to the roof trusses. A composition roofing is used and the floor is of concrete, with a granitoid finish.

The timber is transferred from the planing mill, either over the transfer table or the lighter timber is handled directly from the mill on push-cars. The trucks and such other stores as are kept in the car material building, which lies between the blacksmith shop and the foundry, are placed by the traveling crane on the transfer table and are then pushed directly into the shop. Considerable material, such as bolts, is stored underneath the platforms at the sides of the building, and surplus material, such as large castings and finished lumber, is stored between the tracks, just south of the shop. Ordinarily, three of the tracks in the shop are used for erection purposes while material is being brought in and placed alongside of the other three. If necessary, however, all six tracks may be used for erecting purposes at the same time, and the material can be placed during the

INTERIOR OF COACH SHOP.

FREIGHT CAR REPAIR SHOP.

night time. In this way it is possible to turn out forty-two gondola cars per day.

FREIGHT CAR REPAIR SHOP.

The freight car repair shop is also entirely of steel construction, and lies beyond the transfer table and to the north of it. The space east of the freight car shop is used as a storage or cripple yard and will accommodate about 325 cars. The building is 145 ft. wide x 400 ft. 7⅜ ins. long and has a capacity for about sixty cars. If necessary, it may be extended 200 ft. to the north, increasing the capacity thirty cars. There will still be sufficient room to the north of the extension so that, during favorable weather, about fifty cars may be repaired in the open. The building contains six repair tracks, spaced 20 ft., center to center, and a material track along the western side. A row of work benches is placed along the eastern side. The daylighting is splendid. Stoves are provided so that during cold weather the men will have a place to warm themselves.

NEW FREIGHT CAR SHED.

INTERIOR OF FREIGHT CAR REPAIR SHOP.

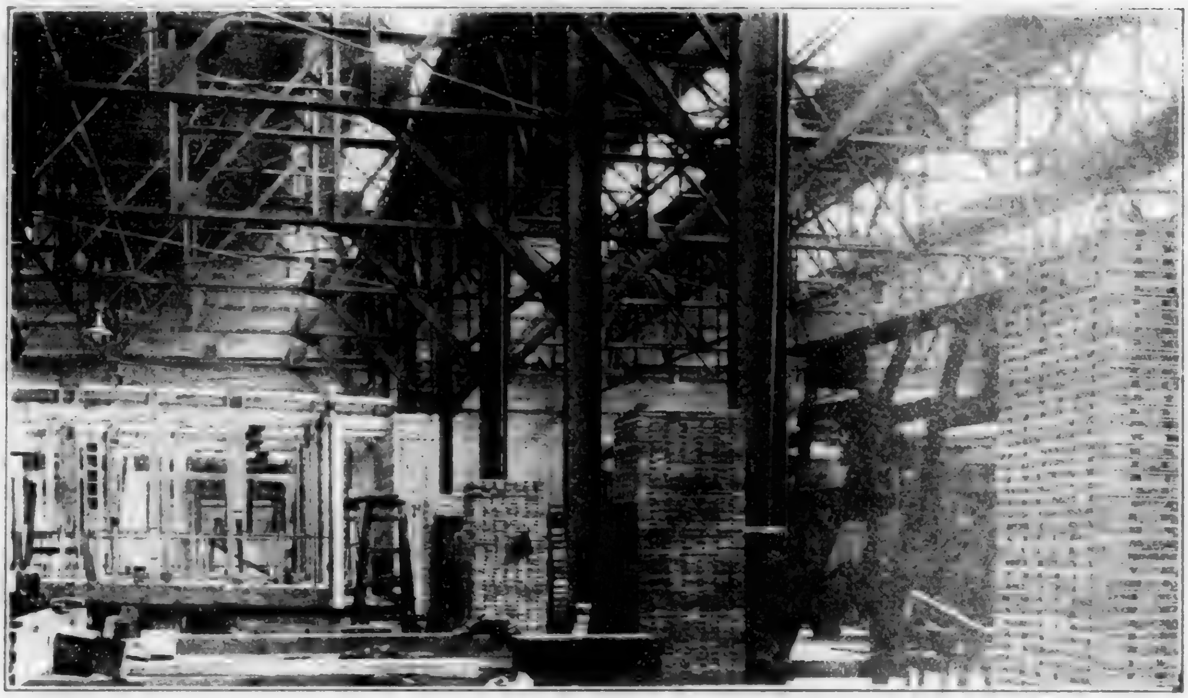
INTERIOR OF NEW FREIGHT CAR SHOP.

The building is lower than the one used for the building of the new cars and, while the cross-section is quite similar as regards shape, the arrangement of the trusses is very different. Only one intermediate row of columns is required for supporting the roof trusses. It has a clere-story and monitors over the center and side bays similar to those on the freight car shop, and has a row of stationary sash on the sides above the corrugated iron sheathing. Along the western side of the building is a platform, or balcony, for the workmen's tool boxes. The foreman's office is elevated and is at the northwest corner of the building, furnishing a view both through the shop and over the freight car repair tracks. The sides and ends of the building are equipped with rolling shutters. The floor is of cement, with a granitoid finish. Between each pair of tracks are compressed air connections, the hose extending down from the roof trusses. As the cars are completed, they are taken out at the north end of the building, are switched out over the belt line at the eastern side of the shop and are then weighed on the scales, which are placed near the southeast corner of the building, and are shown in one of the photographs. They leave the plant at the end at which they are received.

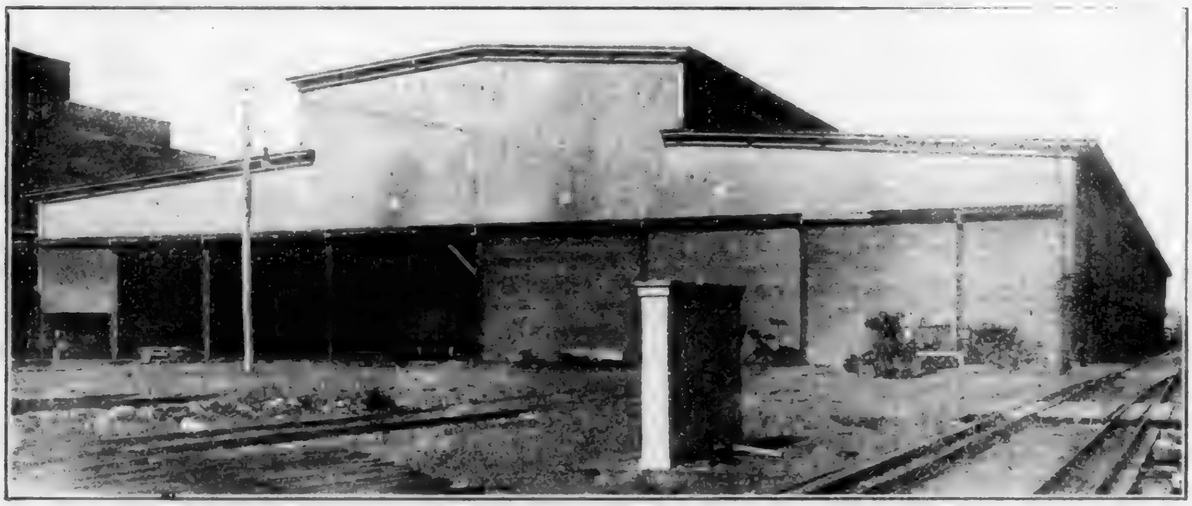
CAR MATERIAL AND WHEEL SHOP.

This building is situated between the blacksmith shop and the foundry alongside of the traveling crane and about opposite the end of the freight car repair shop. It is a steel frame brick building, 90 ft. 7 ins. x 202 ft. 1 in., and is divided into three parts by wooden partitions which extend as high as the underside of the roof trusses. The roof has a wide, high, monitor extending almost its entire length, the sides and ends of which are almost entirely of glass, thus furnishing splendid daylighting. A little over one-third of the building at the north end is used as a wheel shop and for the storage of truck springs and the erection of car-wheel trucks. The two truck-erecting tracks extend out underneath the transfer crane. The wheel shop contains three heavy double Niles axle lathes, No. 3; a Bement & Son single axle lathe; a Pond single axle lathe; a Niles car-wheel lathe; three 42-in. Niles car-wheel boring machines; a Safety Emery Wheel Company emery wheel, and two Niles wheel presses, No. 2, one of which is used for pressing on the wheels and the other for pressing them off. The boring mills are driven by a Bullock 18-h.p. motor, while the rest of the machinery is driven by a 60-h.p. motor of the same make. This machinery is grouped along the north end of the building.

The middle section of the building is used as a freight car storeroom and contains light material, such as small castings,



INTERIOR OF COACH SHOP.



FREIGHT CAR REPAIR SHOP.

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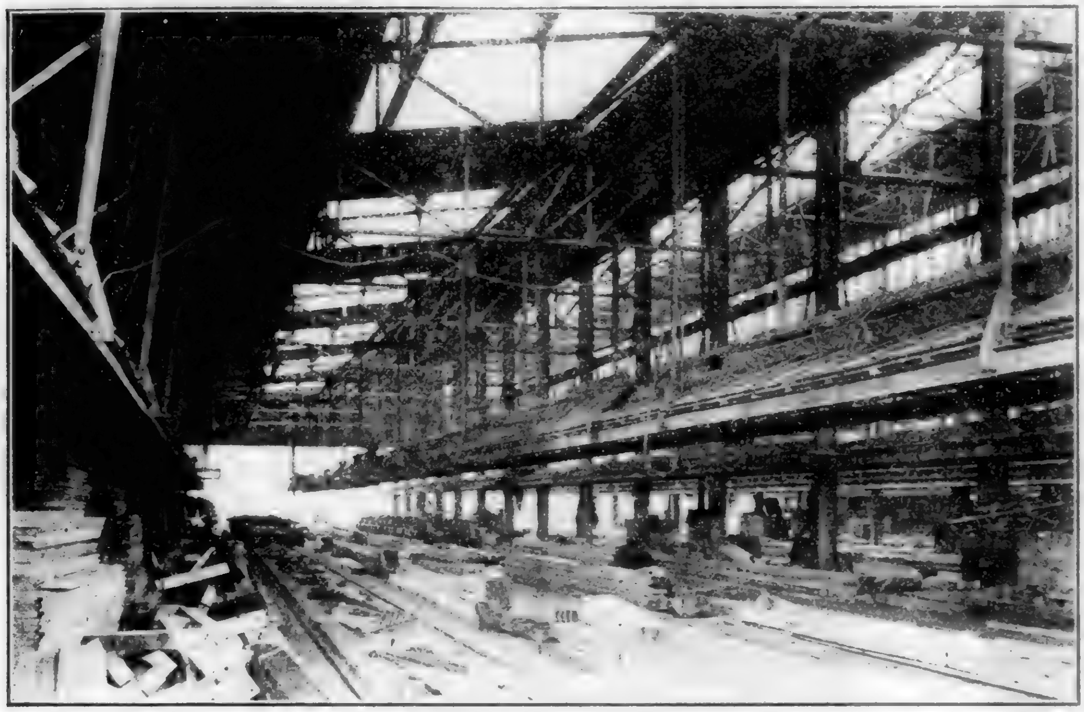

INTERIOR OF FREIGHT CAR REPAIR SHOP.

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CAR MATERIAL AND WHEEL SHOP.

This building is situated between the blacksmith shop and the ... the traveling ... about opposite ... the freight car ... it is a ... building, ... ft. 1 in., and is ... three parts by ... titions which ... high as the ... the roof trusses. The ... has a wide, high ... extending al... the ... ends of ... entirely of gl... nishing ... ing. A ... third of the ... the north end is ... wheel ... storage of ... and the ... wheel truck ... truck-erecting ... tend on ... transfer crane. ... shop ... double Niles axle ... No. 3; a Bement & Son single axle lathe; a Pond singl... lathe; a Niles car-wheel lathe; three 42-in. Niles car-wheel boring machines; a Safety Emery Wheel Co... wheel, and two Niles wheel presses, No. 2, one of which is used for pressing on the wheels and the other for pressing them off. The boring mills are driven by a Bullock ... motor, while the rest of the machinery is driven ... motor of the same make. This machinery is ... the north end of the building.

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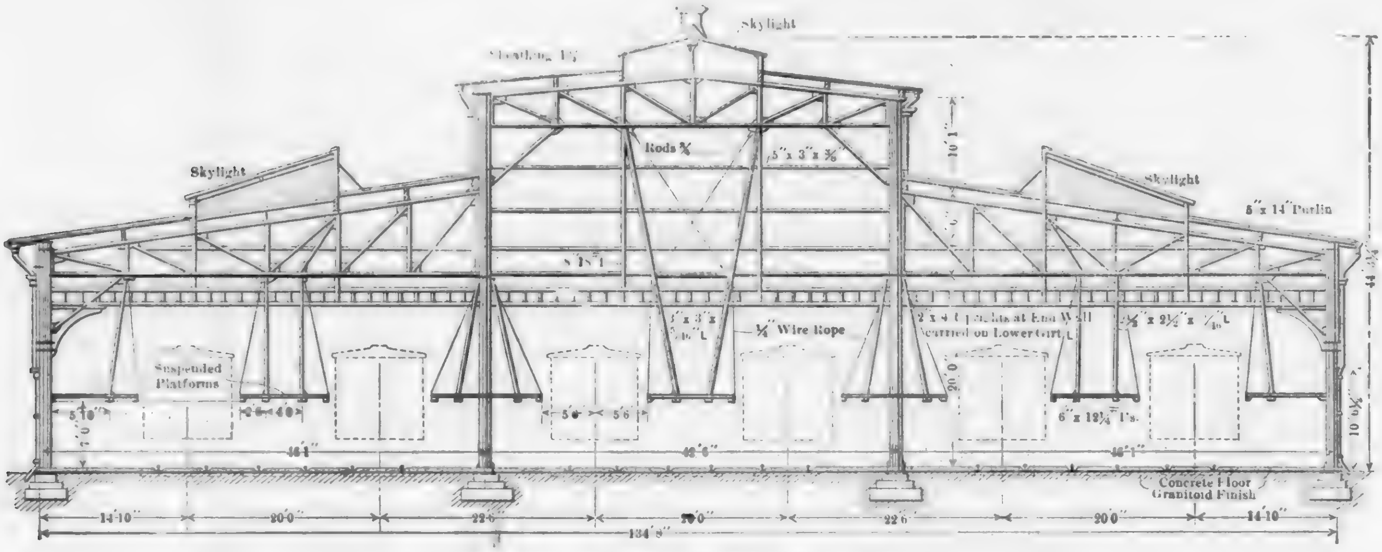
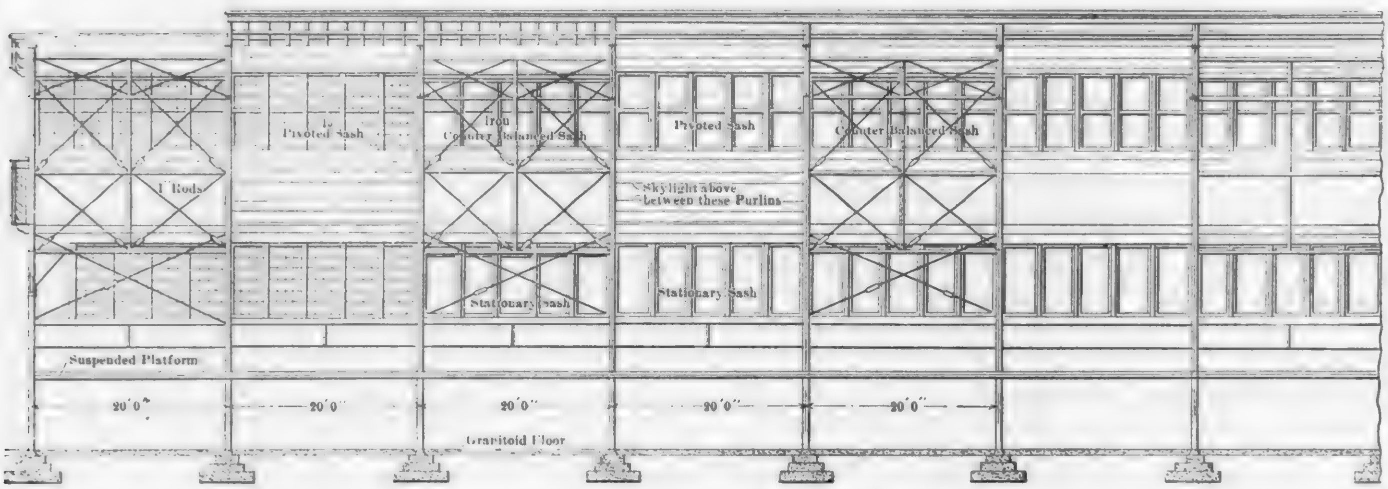
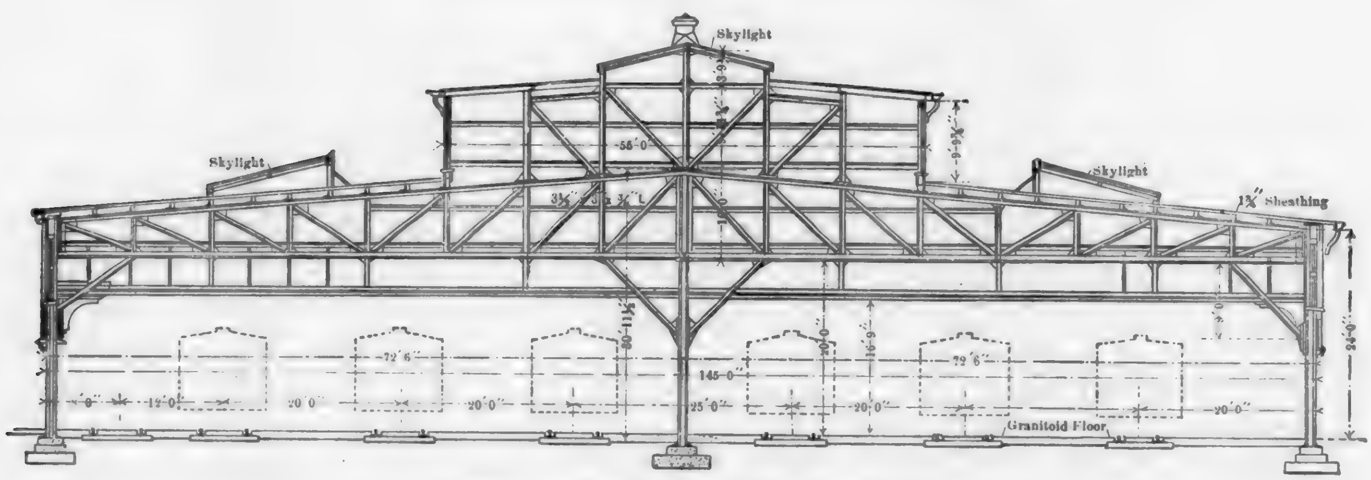


CROSS-SECTION OF NEW FREIGHT CAR SHOP.



PART LONGITUDINAL SECTION OF NEW FREIGHT CAR SHOP.

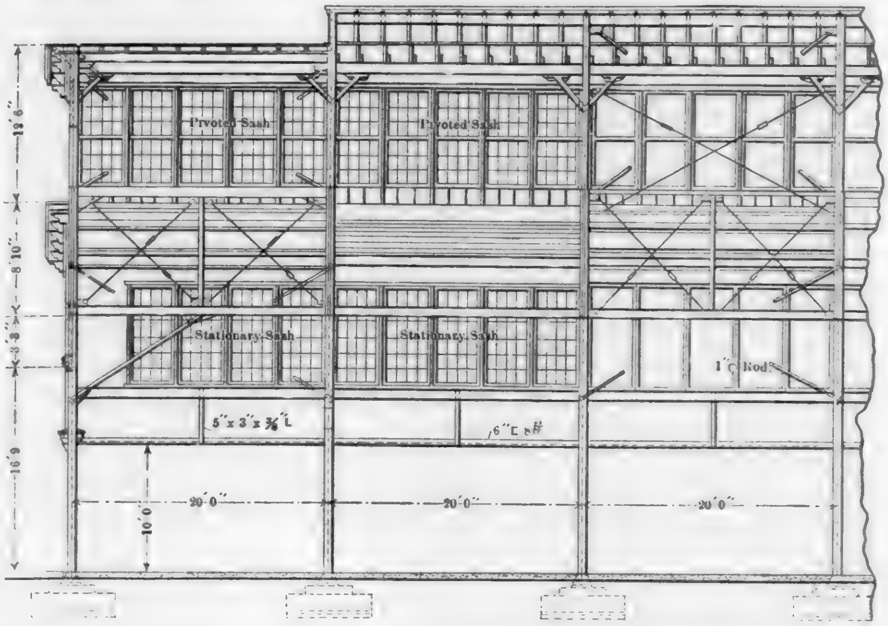


CROSS-SECTION OF FREIGHT CAR REPAIR SHOP.

brake rigging, car roofs, air hose, nails, screws, etc.

The end section of the building is only about half as large as the other two and is used as a pipe shop. It is equipped with two 2-in. Merrill Mfg. Company pipe threaders and a 2½ to 12-in. pipe threading and cutting machine, made by the Curtis & Curtis Company. These are driven by a 8-h.p. Bullock motor. The room is also equipped with large racks for the storage of pipes and with benches and vises for pipe work. It also has apparatus for fitting up air brake hose.

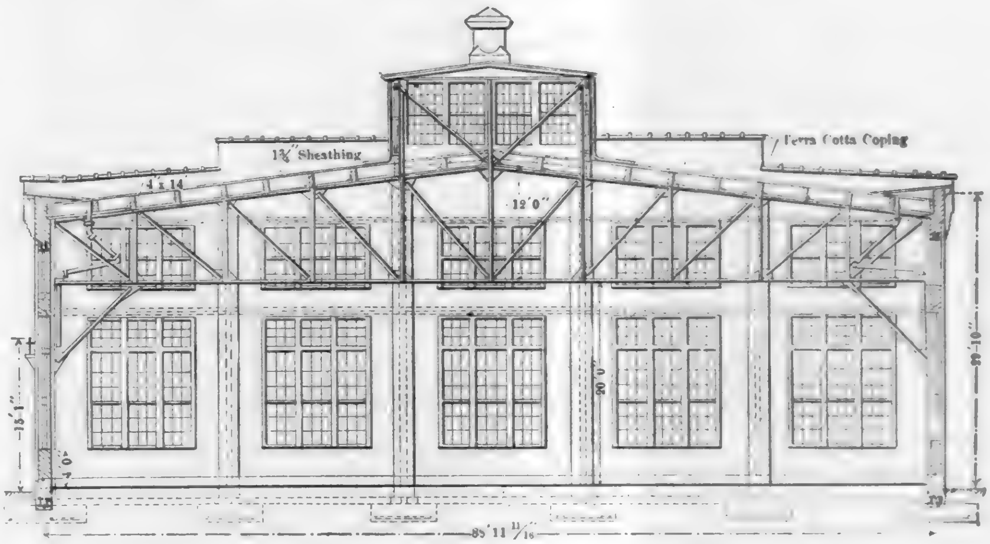
The space west of the shop is used for the storage of car wheels and axles. The space underneath the traveling crane in front of the building is used entirely for the storage of car material, especially for that used in the construction of the trucks.



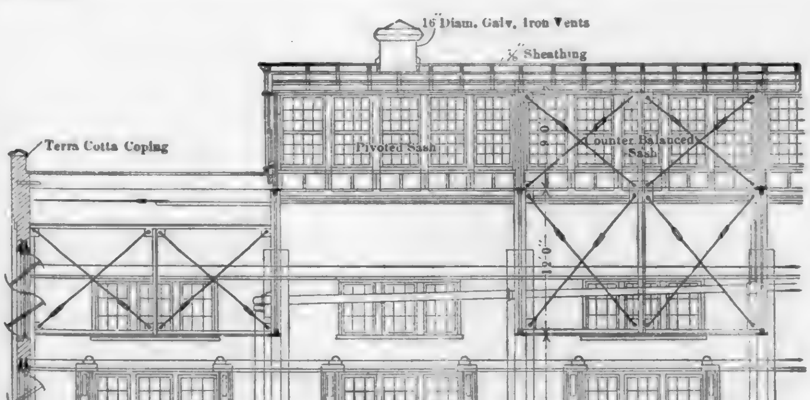
PART LONGITUDINAL SECTION OF FREIGHT CAR REPAIR SHOP.

A. L. A. M. Standard Screw.—The Association of Licensed Automobile Manufacturers has adopted standard dimensions and specifications for hexagon-head screws, castle and plain nuts. The manufacturers of fine machinery have found the pitch of threads of the U. S. standard too coarse and the dimensions of the heads and nuts too large. Different manufacturers have tried to solve the difficulty by adopting dimensions of their own, and this has caused much confusion. The A. L. A. M. have, after careful study and investigation, adopted a set of standards for screws for this finer class of work and hope that it may eventually be generally adopted as standard for such work. The material for use in automobile work will be about twice as strong as ordinary screw stock. For screws of soft material U. S. standard standard pitches will be used.

Street and Electric Railways.—A supplement to the *Street Railway Journal* giving statistics for the street and elevated railway mileage, cars and capitalization shows that in 1905 there were in the United States 1,081 roads, with a track mileage of 33,150, and having 79,751 cars. The capital stock amounted to $1,844,565,136, and the funded debt to $1,524,371,926. Canada, including Newfoundland, had 42 roads, with a track mileage of 956 and 2,697 cars. The capital stock of these roads amounted to $42,935,636, and the funded debt to $30,906,597. In the insular possessions of the U. S., including Hawaii, Porto Rico and the Philippines, there are six roads having 87 miles of track.



CROSS-SECTION OF WHEEL SHOP AND FREIGHT CAR MATERIAL BUILDING.



PART LONGITUDINAL SECTION OF WHEEL SHOP AND FREIGHT CAR MATERIAL BUILDING.

Cleaning and Oiling Belts.—Belts which have become too greasy and dirty should be cleaned with gasolene, then scraped and wiped with waste. In dry, dusty places it is well to brush them occasionally with a broom or stiff brush. No rosin or belt dope should be used except fish oil and tallow mixed in equal parts. Apply hot with a brush when the belt is running, or dip the belt in the dope tank, then dry and wipe off any grease which may have hardened on the belt. If applied while running, care should be taken not to get too much on the belt, or it will cause it to slip. No mineral oil should be allowed to come in contact with belts. New belts should be treated with fish oil and tallow before using, and any belt which becomes dry, hard and glossy in service should have an application of the dressing. This is especially true of belts in blacksmith shops. The oil will check to some extent the evil effects of the smoke, sulphur gases and dirt, and the life of the belt will thereby be lengthened.—*Mr. C. J. Morrison, American Machinist.*

Don't look for trouble unless you can handle it when you find it.

STANDARDIZING LOCOMOTIVE EQUIPMENT.

CANADIAN PACIFIC RAILWAY.

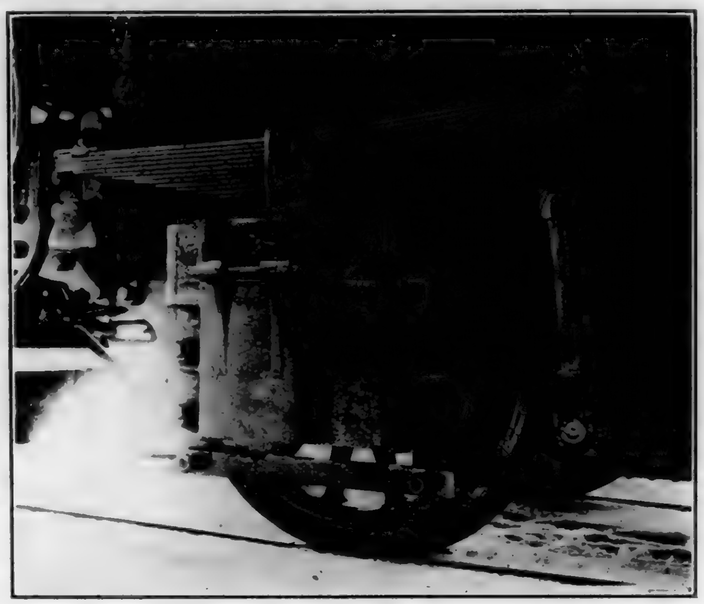
IV.

Radial Trailer Truck.—In connection with the class G1 and G2 Pacific type locomotives, general drawings and description of which were given on page 163 of the May issue, a design of radial trailer truck has been adopted as standard which differs in many respects from any of the designs now in general use on other railroads.

The rear frames of these engines are outside the trailer wheels and connect to the main frames through a heavy cast steel cross connection below the front mud ring. They are of plate, 2 ins. thick and about 12 ins. deep at the connection. A very broad deck casting spaces and stiffens them at the rear.

The pedestal is formed by two steel castings bolted on the outside of the frame. The faces of these castings are about 8 ins. broad and set at an angle with the center line of the locomotive, the front one being about 69 deg. and the rear 71½ degs. This gives the trailer wheel a movement at a radius of 10 ft. 7½ ins., making the center just back of the rear driving axle.

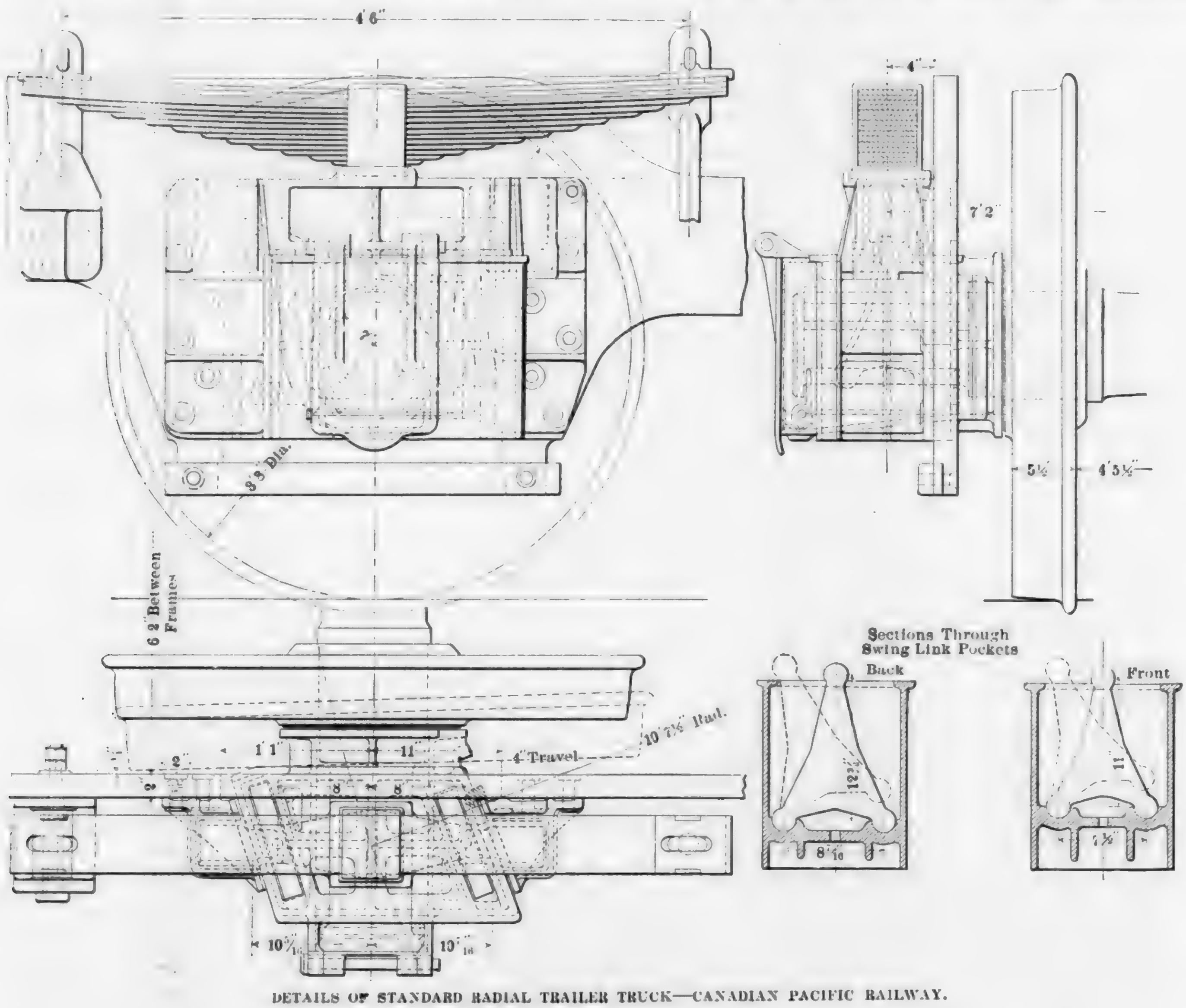
The journal box, a detail drawing of which is shown herewith, fits between the pedestals, having its bearing faces at the proper angles. There is but one lug for stopping the side motion, that being on the inner side of the front face. Parallel to the pedestal-bearing faces on either side are cored deep recesses in the box, of the shape shown by the cross section. In these recesses, triangular shaped struts rest in depressions formed at the bottom into bearings for the two lower legs, while the upper leg projects slightly above the top of the box.



STANDARD TRAILER TRUCK—CAN. PAC. RY.

Resting on top of these swing links is the spring seat of cast steel, a detail drawing of which is also shown. This spring seat is prevented from moving sidewise by having its ends fitted into pockets in the top of the pedestal casting, its vertical movement, however, being free. The semi-eliptical spring outside of the frame rests on the center of this casting.

The action of this truck is such that it offers considerable

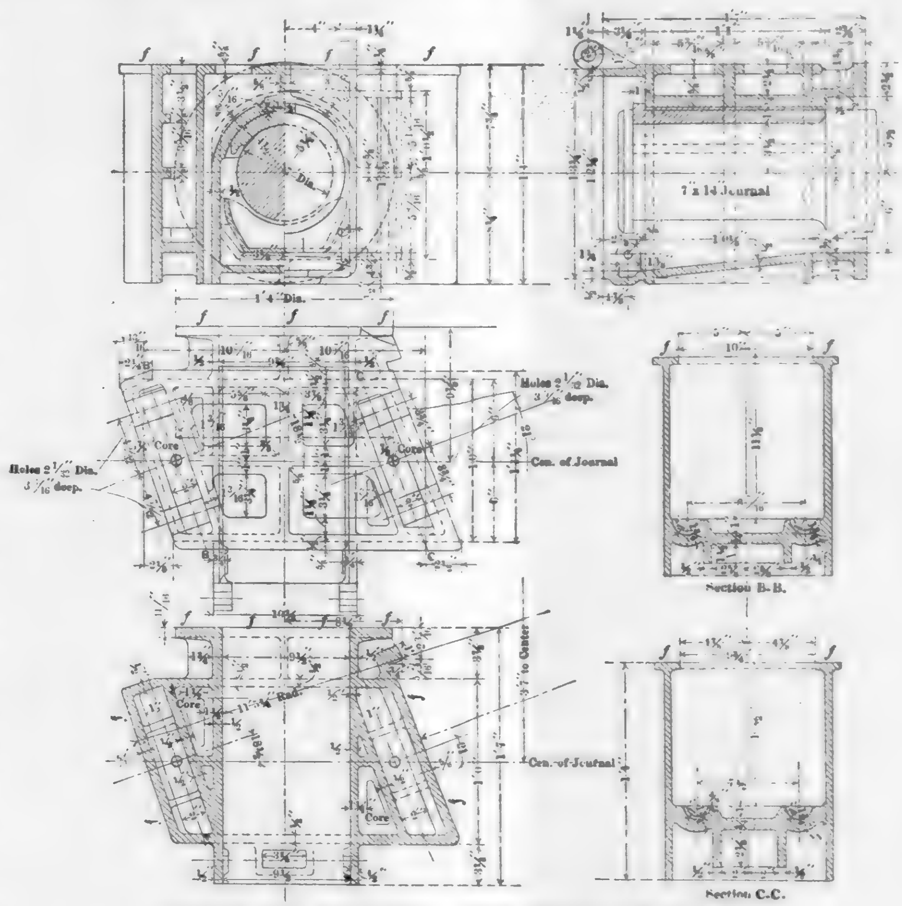


DETAILS OF STANDARD RADIAL TRAILER TRUCK—CANADIAN PACIFIC RAILWAY.

initial resistance to the lateral movement of the rear end of the engine, the amount of this resistance decreasing as the lateral displacement increases, until it becomes exceedingly small at the extreme movement allowed of 4 ins., the result is that, on straight track at any speed so far reached by the engines, this truck acts as though it were rigid, and there is a complete absence of the swinging horizontal movement occasionally found in long and heavy engines.

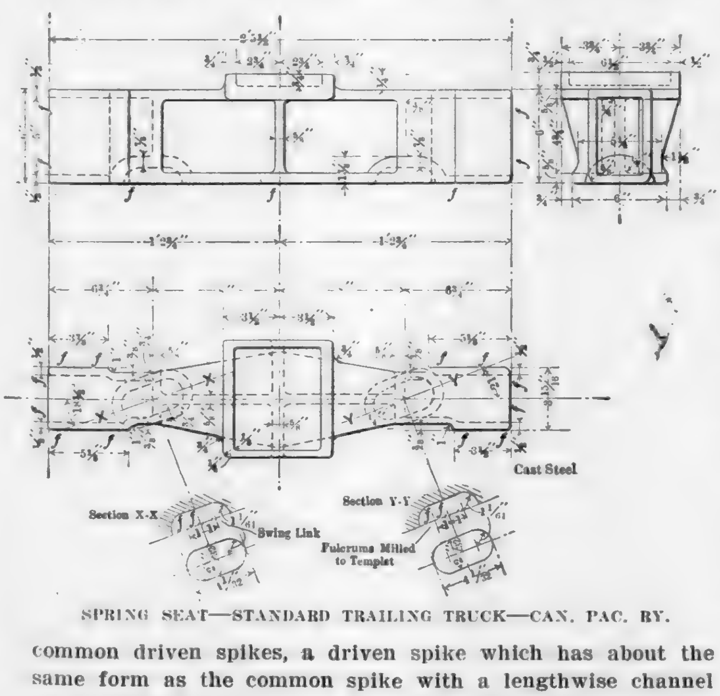
On switches and severe curves, when once the truck has been moved sideways, it gives way easily and allows the front truck to guide the engine around the curve without its action being opposed by the lateral resistance of the trailing truck that is the case in all other designs. The results obtained from this truck in service are very satisfactory. The road on which the engines are working is heavily graded, with frequent curves as high as six degrees in curvature, which are taken freely and steadily at high speeds, and after from six to nine months' service there is no evidence of any flange wear on any of the wheels, and no defect has yet been noticed in the track, in spite of the fact that these engines are considerably heavier than the other power in service.

An application for a patent for this design of truck has been applied for in the United States.



JOURNAL BOX—STANDARD TRAILING TRUCK—CAN. PAC. RY.

Holding Power of Railroad Spikes.—The Forest Service has completed a series of tests to determine the holding power of different forms of railroad spikes. The tests were made on ordinary commercial ties of loblolly pine, oak, chestnut, and other woods. The spikes used were of four kinds:



SPRING SEAT—STANDARD TRAILING TRUCK—CAN. PAC. RY.

common driven spikes, a driven spike which has about the same form as the common spike with a lengthwise channel on the side away from the rail; screw spikes of the American type; and screw spikes similar to those in use on European railroads, and differing from the American spike mainly in the manner of finishing the thread under the head. The common and the channeled spikes were driven into the ties in the usual manner to a depth of 5 ins. A hole of the same diameter as the spike at the base of the thread was bored for the screw spikes, which were then screwed down to the same depth as the driven spikes. The ties were then placed in the testing machine, and the force required to pull each spike was recorded.

The average force required to pull common spikes varies from 7,000 lbs. in white oak to 3,600 lbs. in loblolly pine, and 3,000 lbs. in chestnut. The holding power of the channeled spike is somewhat greater; for example, about 11 per cent. more force, or 4,000 lbs. is required to pull it from the loblolly pine tie. The two forms of screw spike have about the same holding power, ranging from 13,000 lbs. in white oak to 9,400 lbs. in chestnut, and 7,700 lbs. in loblolly pine. There is a marked difference between the behavior of driven and screwed spikes in knots and in clear wood. Knots are brittle and lack elasticity, so driven spikes do not hold as well in them as in clear wood. In the case of common spikes in loblolly pine the decrease of holding power in knots is as great as 25 per cent. On the other hand, screw spikes tend to pull out the whole knot which they penetrate. This increases the resistance so much that in loblolly pine the increase of holding power of screw spikes in knots is about 35 per cent. over that for clear wood.

Estimating the Weight of Tubes.—Below is a rule which I have found useful for finding the weight per running foot of pipes, tubes and columns, and is expressed in the following formula:

$$W = K\ (D^2 - d^2)$$

in which

D = outside diameter.
d = inside diameter.
W = weight per running foot.
K for wrought iron = 2.64
K for cast iron = 2.45
K for brass = 2.82
K for copper = 3.03
K for lead = 3.86

The constant for cast iron (2.45) is based on cast iron weighing 0.26 pounds per cubic inch, or 450 pounds per cubic foot. It is best to add 10 per cent. to these figures in order to provide for overweight in the foundry.—*Alex. C. Labar, in Machinery.*

(Established 1832).
AMERICAN ENGINEER AND RAILROAD JOURNAL
PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE.

J. S. BONSALL,
Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT, } Editors.
E. A. AVERILL, }

OCTOBER, 1906.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

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Several communications have recently been received by the editorial department requesting us to present articles on certain subjects. We are always pleased to receive letters of this kind; in fact, the more of them we receive the better we like it. It is advisable, however, that the writer give his name and address, as in several instances the information requested had already appeared in our columns, or was such that we could not very well present it, although we could very readily have advised the writer just where he could obtain the information, and would have taken pleasure in doing so if we had known his proper name and address.

The purchase of five locomotives of the Mallet articulated compound type by the Great Northern Railway, one of which is illustrated in this number, probably marks the beginning of a fairly general use of this type of locomotive where conditions for which it is specially adapted are found. The only previous example in this country, which has been in pushing service on the Baltimore & Ohio Railroad for over two years, is reported to be entirely satisfactory as regards design and service, and the type in smaller sizes has been in successful operation in other countries for a number of years. As far as the type itself is concerned, it can safely be accepted as a success, from an operating standpoint, at least. But, considering individual examples of a size which have thus far been used in this country having over 70,000 lbs. tractive effort, their ultimate success in service approaching regular road work will no doubt largely depend upon the introduction of a successful mechanical stoker capable of covering 78 sq. ft. of grate area with coal at the rate of over 3 tons an hour.

In large manufacturing concerns it is very often customary for the publication department to examine the technical papers which are received and to mark certain articles and forward them to such of their engineers as may be specially interested in that particular subject. An application of this same system was recently found in the motive power department of a large railroad. The technical papers are carefully examined, and such articles as may be of interest to different foremen are forwarded to them. A list of the technical journals which each foreman takes is kept in the office, and when the article to which it is desired to call his attention is in one of these papers he is sent a note referring him to the article and to the page upon which it will be found. The management of the road realizes the importance of having its foremen carefully read the technical papers, and encourages them to do so. In fact, it is deemed of such importance that if a good man is found who does not read at least one technical paper he is given to understand that he must do so in order to be eligible for promotion.

A number of railroads have taken up the question of furnishing their apprentices with instruction in mathematics and mechanical drawing. In several instances where this has been done in the past it has fallen flat, or, at least, not produced the results it should, because the courses were not properly arranged. It is usual, in taking up mechanical drawing in our technical schools, to start in with work on geometrical exercises, and it is some time before the student is allowed to make a practical application of the principles learned in this way. This treatment does not appeal to the average apprentice. He is primarily interested in the practical application of the principles involved, and he should therefore be started by drawing from the very simplest objects and then slowly be advanced, the various geometrical principles being introduced as he finds it necessary to apply them. The instructor too often makes the mistake of advancing the work too rapidly, forgetting that the environment and the work done by the apprentice is such that his mind is not as keen as that of a student, that the simplest problems are often difficult for him to comprehend, and it is only by many simple applications that he becomes familiar with them. The same is true of mathematics, and care should be taken that the examples given

are in line with the work done in the shop, so that the apprentice can readily see their practical application. By very gradually leading him on he can gain a fair working knowledge of mathematics and finally, with the simpler principles of algebra, geometry and trigonometry, without knowing that he is dealing with such formidable subjects.

The following extract from a letter recently received requires no comment:

"I am one of the many who take special interest in your journal, not only because of its helpfulness along production-improvement lines, but because of your defense of motive-power men in general who have not yet attained the recognition they rightfully deserve. After seven years of hard work I have attained a general foremanship, but the prospects are such that I am now preparing to duck, study telegraphy and railroad accounting, and go into the operating department."

The list of capable men who have left responsible positions in the motive power department to take more lucrative positions in other fields during the past year and of the promising young men, well equipped for effective work in that department, who have found it to their interest to go into other lines of business is entirely too large. It is true that on some few roads there has been quite a marked improvement of conditions, but the work and responsibilities have increased in a greater ratio. When will the railroads realize the importance of the motive power department and place it on its proper basis? When a man spends years in training himself for a certain class of work something must certainly be wrong when it proves to his advantage to give up his chosen profession and seek other fields. It is strange indeed if the railroad managements can find it to their interest to make the motive power department a training school to fit men for other classes of work and that they can afford to let men go after they have made records so good that the attention of outside parties is attracted to them.

After experimenting for over a year with a large freight locomotive, the boiler of which was fitted with a good-sized combustion chamber, during which time it was run on several different divisions and given the most severe service where boiler conditions were the worst, the motive power department of the Northern Pacific Railroad has found the design so much of a success that they specified combustion chambers bers on the order of 70 locomotives, covering both freight and passenger types, which have recently been delivered. When it is stated that the trouble with leaky flues was 75 per cent. less on the combustion chamber engine, compared with the same design of locomotive not so fitted and working under identical conditions, the reason for this action is easy to understand. It was also found that the opportunity to work on such flues as did leak without removing the brick arch was an advantage not to be overlooked. The engine steamed equally well with the others, hauled the same tonnage, and is capable of making a greater mileage.

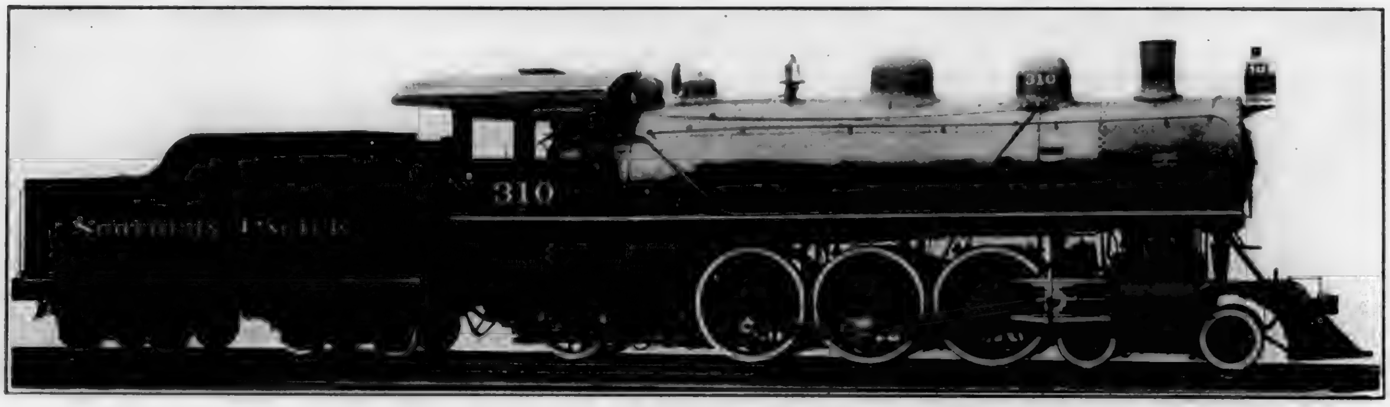
The combustion chamber was used in the original Wooten fireboxes and remained a part of that design until it was found to be of no particular advantage and the engines without it steamed as well and were less expensive to maintain. That experience seems to have been accepted as applying to locomotives burning soft coal, when the wide and shallow firebox was first introduced, and in spite of the accompanying greatly aggravated flue troubles, so far as we know, this is the first attempt to see what results a combustion chamber would give with bituminous coal. There is a great difference in the burning conditions of the two different kinds of fuels, as regards flame length, amount of gas given off, depth of firebed, and hence the amount of air admitted, and it would seem unwise to accept the experience on the hard coal burners as applying to locomotives burning soft coal. Judging from the experience on the Northern Pacific, there are decided advantages in this arrangement when used with soft coal which were not evident in its previous trial.

THE SURCHARGE PROBLEM.

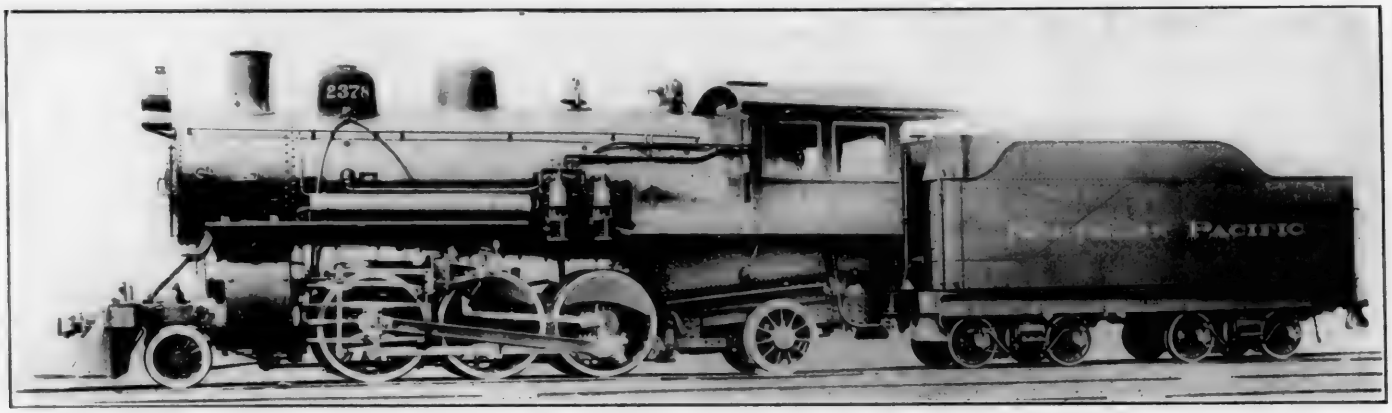
An article which is of the very greatest importance to the motive power department and which should be very carefully studied by all those who are interested in placing railroad shops on the best possible basis, as concerns output and economy, is that by Mr. C. J. Morrison, on "The Surcharge Problem," page 376. The very word "surcharge," or "burden," as it is sometimes called, is a strange one to the average railroad shop superintendent, and even to his superior officers, and yet it is a very common word and one whose significance is readily understood in an up-to-date manufacturing establishment. The manufacturer realizes that the actual cost of labor for making a given article plus the cost of the material is rather a small item compared to what he must sell it for in order to make a reasonable profit. The average shop superintendent, or, to make it more emphatic, the average superintendent of motive power, when he wishes to determine whether it is advisable, from the standpoint of economy, to make a given article in his own shops or to buy it ready made from the manufacturer, will at once proceed to get the data relating to the cost of material and the actual labor cost involved in making the article. These he will add together and then arbitrarily add a certain per cent., either of the labor cost or of the labor cost plus the cost of material, to cover the surcharge; or, as he will doubtless call it, the expense for supervision.

Mr. Morrison has very rightly stated that it is very doubtful if there is more than one railroad in this country that can correctly state the surcharge for any given department. We feel pretty safe in going even farther than Mr. Morrison and stating that it is exceedingly doubtful if the average surcharge for the entire locomotive or car department is either known or understood by one shop superintendent or mechanical superintendent out of ten. As may be seen from Mr. Morrison's figures for a number of shops, the surcharges for a modern railroad shop, and he has very carefully specified what they are as expressed by a percentage of the payroll, amounted, on an average, to 60 per cent. for the locomotive department and 38 per cent. for the car department, although it has been found that the surcharges varied in the different departments of one locomotive shop from 40 to 220 per cent. This will probably be a great surprise to most of the men at the head of our motive power departments, and it will undoubtedly be to their interest to investigate the matter in connection with their own shops. Undoubtedly it will be found that some articles that are being manufactured by the railroad company might be purchased at a less cost to the company and that it will be greatly to their advantage to manufacture certain articles that are now being purchased.

Another exceedingly important question which may readily be solved by a knowledge of the exact amount of the surcharge for each department is the matter of replacing old machine tools by newer ones of greater capacity and improved design. It is not at all uncommon to find that it is necessary to crowd the machine tools in order to have a sufficient number to take care of the output, and yet in the same shop will be found tools, taking up valuable space, that are in poor condition and, in some cases, anywhere from 20 to 50 years old. In a great many instances it ought not to be necessary to even have to go to the length of producing any figures to show that the space occupied by these tools could be used to very much greater advantage by taking them out and replacing them with up-to-date tools; but if those in charge should very carefully and accurately calculate the surcharge on these particular machines it would furnish them with a good, strong and logical argument to present to their superior officers to demonstrate the importance of judiciously improving the condition of the equipment.



PACIFIC TYPE LOCOMOTIVE WITH COMBUSTION CHAMBER—NORTHERN PACIFIC RAILWAY.



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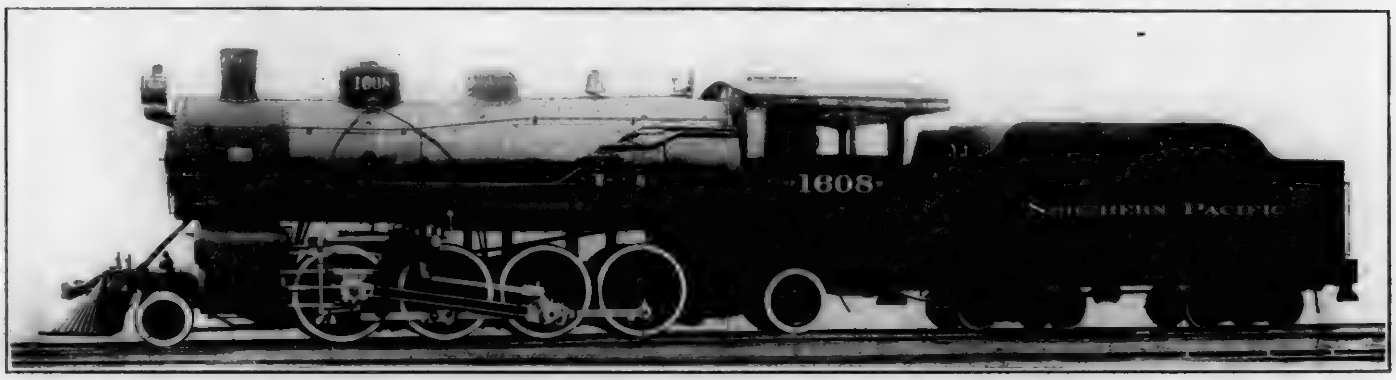


MIKADO TYPE LOCOMOTIVE WITH COMBUSTION CHAMBER—NORTHERN PACIFIC RAILWAY.

FREIGHT AND PASSENGER LOCOMOTIVES WITH COMBUSTION CHAMBERS.

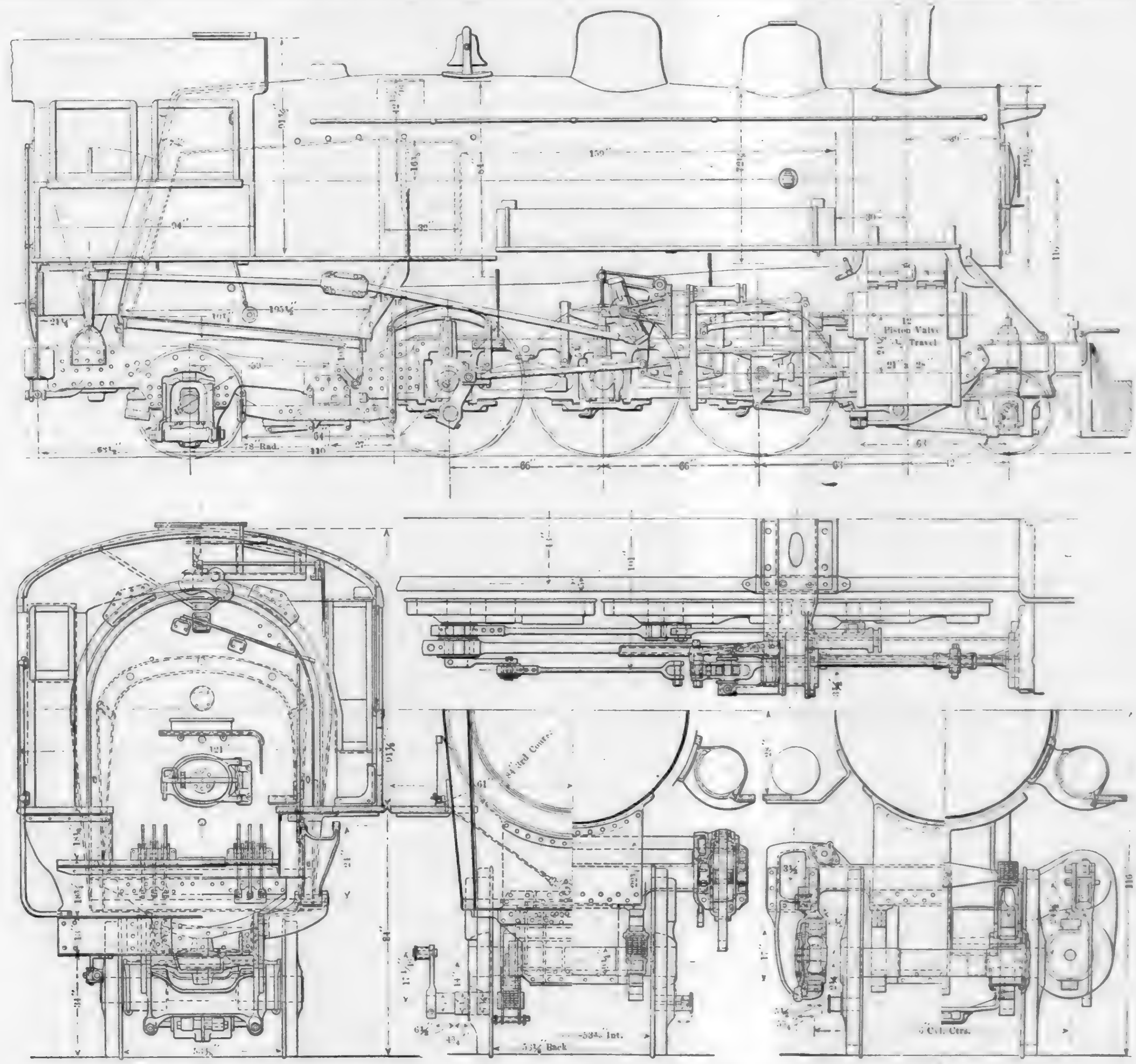
NORTHERN PACIFIC RAILWAY.

The American Locomotive Company during the past few months has delivered an order of 70 locomotives to the Northern Pacific Railway Company, all of which are fitted with boilers having a combustion chamber. This order is divided between three different types, there being 20 of the Pacific type, 30 of the Mikado type and 20 of the Prairie type. One engine of the Pacific type is fitted with the latest design of Schenectady superheater, and one of each of the other two types is equipped with Walschaert valve gear. The Pacific and Mikado type engines are both identical in design with the locomotives built by the same company for this road a little over a year ago, with the exception of the boilers. The previous order consisted of 25 Mikado type, of which six were tandem compounds and five Pacific type. These engines were illustrated and described in this journal in January, 1905, page 5, to which reference can be made for details.

The boilers on the Pacific type engines already in use, which are known as Class Q1, were 72¼ ins. outside diameter of the first ring, and contained 347 2-in. flues 18 ft. 6 ins. long. They were of the radial stay, extended wagon top type. The changes made in the boilers of these later engines, as can be seen by reference to the illustration, include the introduction of a 3-ft. combustion chamber and a reduction in the number and length of flues. In other respects the boilers are the same. The front flue sheet was set somewhat farther forward, so that it gives flues 16 ft. 9 ins. long, or but 1 ft. 9 ins. shorter than the previous engines, although the combustion chamber is 3 ft. in length. The flues are spaced 1-32 in. farther apart, so that there are but 306, as against 347 in the previous class. The differences in heating surface will be considered later.

In the Mikado type, however, the boiler has not been changed outside of the introduction of the combustion chamber, which shortens the flues by its full length. One of this type of the previous order was fitted with a combustion chamber, and it is the experience obtained by the operation of this engine under the most difficult conditions that has led to the specifying of combustion chambers for this large order.

This is the first of the Prairie type engines to be built for the Northern Pacific Railway, and the one illustrated, as equipped with Walschaert valve gear, weighs 209,500 lbs., of which 152,000 lbs. is on drivers. They have 21x28-in. cylin-



ELEVATIONS AND SECTIONS OF PRAIRIE TYPE LOCOMOTIVES—NORTHERN PACIFIC RAILWAY.

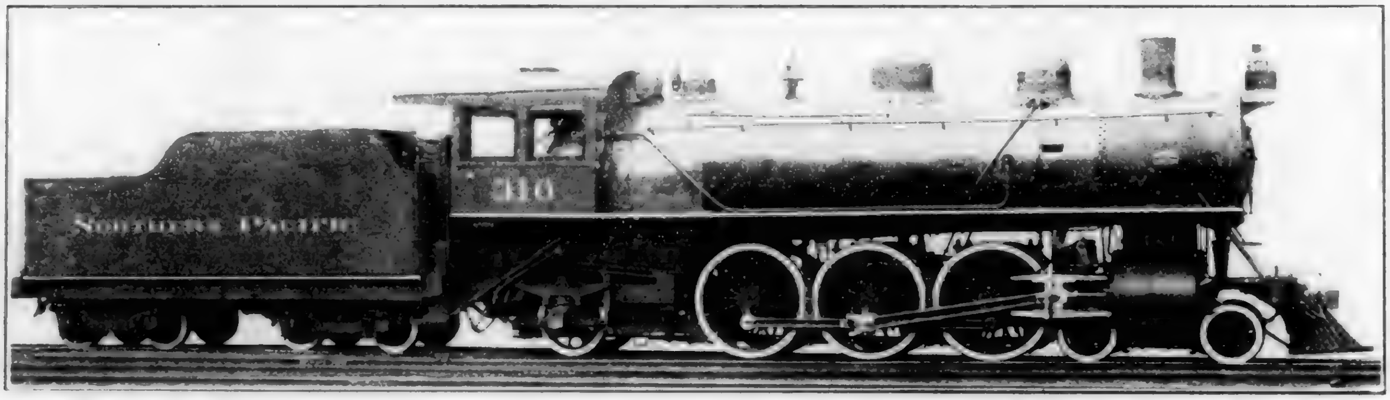
ders with piston valves, and give a tractive effort of 33,300 lbs., the wheels being 63 ins. in diameter. The rigid wheel base is but 11 ft., and since the front axle is but 63 ins. from the center of the cylinder, it made it necessary to connect the main rod to the rear pair of drivers. The boilers of these engines necessarily have short barrels, and the introduction of the combustion chamber, although it is somewhat shorter than on the other two types, shortens the flues to 13 ft. 3 ins., which gives a heating surface in the tubes of but 2,105 sq. ft. Twelve-inch piston valves are used, having a travel of 5 ins. when equipped with the Stephenson motion, and 5½ ins. with the Walschaert gear. The design and arrangement of the Walschaert motion is clearly shown in the illustration.

As mentioned above, one of the Pacific type engines is equipped with the latest design of Schenectady superheater, which will give an opportunity of comparing the performances of three different arrangements of the same locomotive operating under the same conditions, as this road now has a Pacific type locomotive with long flues, without a combustion chamber; the same locomotive with the changes as mentioned, including combustion chamber, and the same engine equipped with superheater and combustion chamber; the design being identical in all respects outside of the boiler.

The accompanying table gives the general dimensions and weights of these locomotives, as well as the early Pacific and Mikado types, and from it comparisons can be made showing the effect of the introduction of the combustion chamber and superheater.

It will be noticed that an equalized type of truck has been placed under the tender of the Pacific type engines which carry 7,000 gals. of water and 12 tons of coal. The tenders of the Mikado type have a capacity for 10,000 gals. of water and 12 tons of coal.

The use of the combustion chamber on wide firebox locomotives burning soft coal is advocated by Mr. David Van Alstyne, mechanical superintendent of the Northern Pacific Railroad, who has probably given the design and service of locomotive boilers greater and more careful study than any other man in the country. His observation has led him to believe that the introduction of the combustion chamber will reduce many of the troubles now found with boilers, especially in bad water districts, and will also be an improvement over the present design in other respects. The advantages claimed for a combustion chamber are the facts that it removes the ends of the flues away from the hottest part of the fire; that it permits working on the flues without removing the brick arch; that it adds materially to the heating surface of the firebox, and also that it gives a largely increased fire



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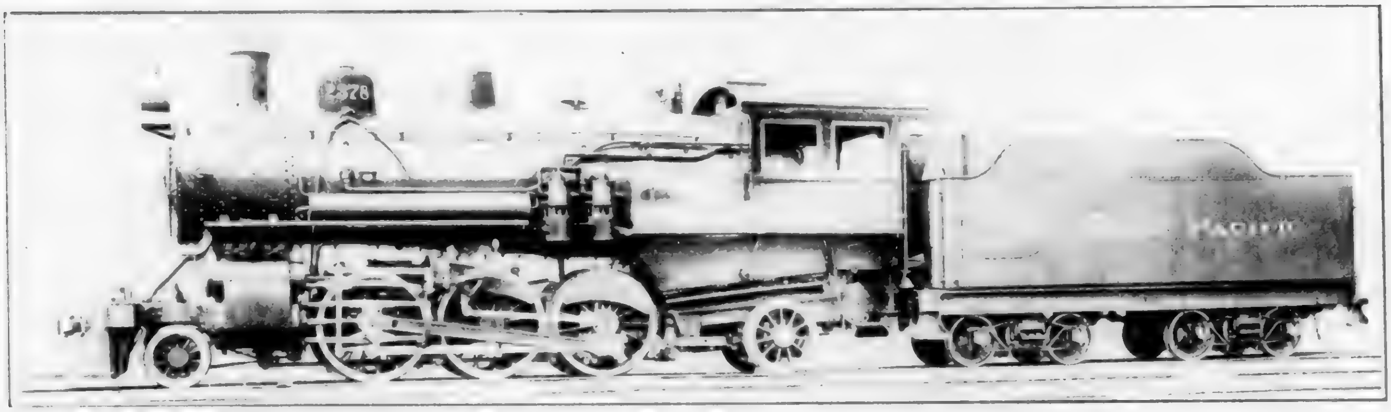

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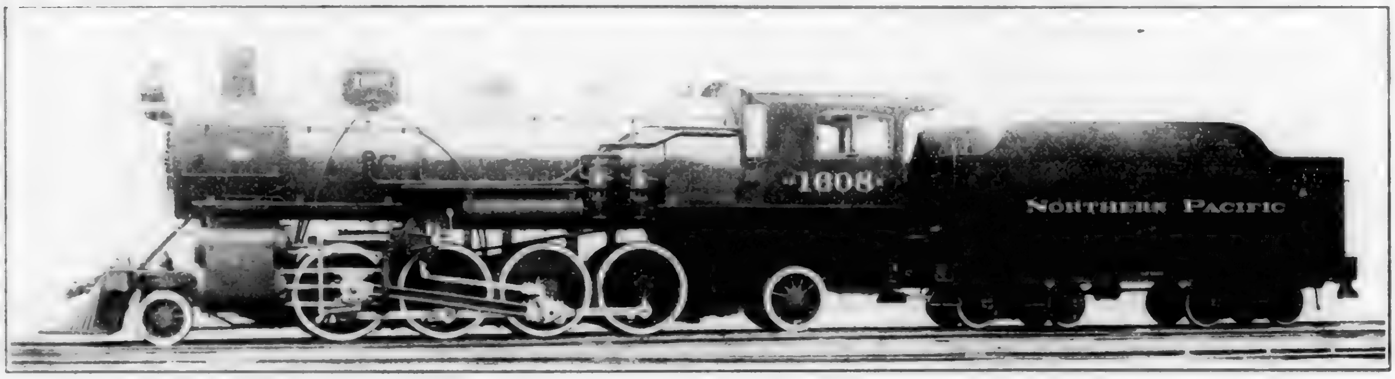

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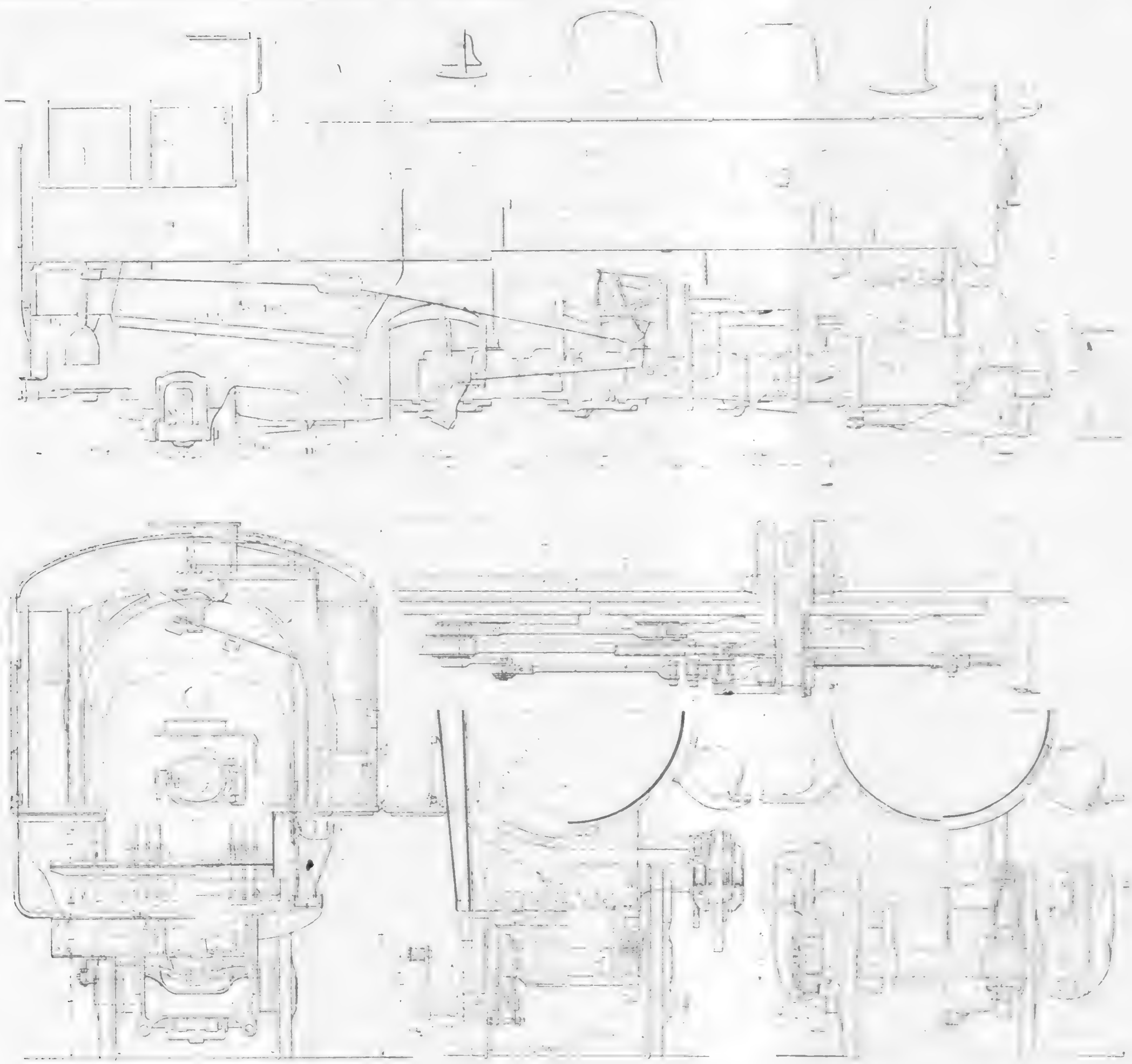

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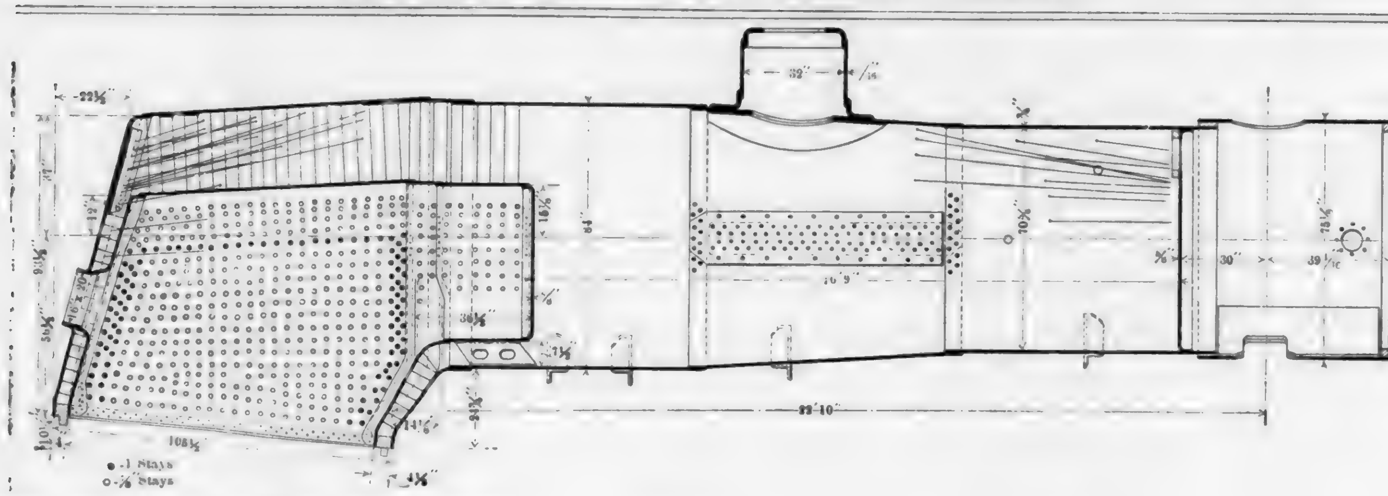
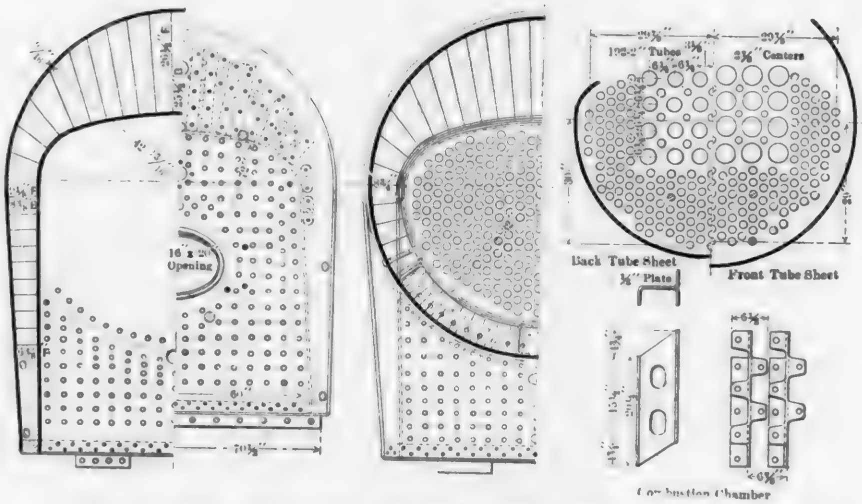


box volume, which will tend toward better combustion.

In order to test the soundness of the theory in a practical way Mr. Van Alstyne specified a combustion chamber on one of the early order of Mikado type locomotives, as mentioned above, which was put into service early in 1905, and has since been operated on several different divisions of the road where boiler troubles were the most numerous and where the water conditions were the worst. The service of this engine was watched carefully, and it was found to be a large improvement. In spite of the fact that there had been a considerable reduction in actual heating service, the engine was found to steam equally well with those having a greater actual heating surface, and, furthermore, this engine required only about one-quarter as much work to be done on the flues, and that on a division where the water conditions were notoriously bad. What work was necessary on the flues could be done without removing the brick arch, which is an economy not only in money, but in time as well. It was also found that there was no collection of cinders in the combustion chamber and that the flues were all open. That the service of this engine was eminently satisfactory from all standpoints is best evidenced by the fact that combustion chambers have been specified on all of this last order of 70 engines, which include passenger as well as freight engines.



BOILER WITH COMBUSTION CHAMBER, PACIFIC TYPE LOCOMOTIVE—NORTHERN PACIFIC RAILWAY.

Type	Pacific	Pacific	Mikado.	Mikado	Prairie
Combustion chamber	Without	With	Without	With	With
Weight on drivers ÷ tractive effort	4.6	4.72	4.2	4.4	4.55
Total weight ÷ tractive effort	7.1	7.2	5.55	5.4	6.3
Weight on drivers ÷ total heating surface	40.4 lbs.	49.2 lbs.	48.3 lbs.	59.5 lbs.	65 lbs.
Total weight ÷ total heating surface	62.0 lbs.	75 lbs.	63.5 lbs.	75.9 lbs.	89.5 lbs.
Total heating surface ÷ grate area	81	68.5	93.5	79	53 8
Firebox heating surface ÷ grate area	4.34	5.53	4.8	5.62	5.4
Firebox heating surface ÷ total heating surface	5.35 %	8.1 %	5.15 %	7.15 %	10.1 %
Equated heating surface = (tube H. S. ÷ square root of the length tubes in ft.) + firebox H. S.	965.3 sq. ft.	910.6 sq. ft.	1,070.2 sq. ft.	1,030 sq. ft.	813.3 sq. ft.
Weight on drivers ÷ equated heating surface	148 lbs.	161 lbs.	183 lbs.	199 lbs.	186.5 lbs.
Equated heating surface ÷ grate area	22.2	21	24.6	23.7	18.7
Tractive effort x diam. drivers ÷ actual heating surface (B. D.)	607	720	720	835	900
Tractive effort x diam. drivers ÷ equated heating surface	2.220	2.350	2.740	2.890	2,580
Volumn both cylinders	11.4 cu. ft.	11.4 cu. ft	15.7 cu. ft	15.7 cu ft.	11.2 cu ft.
Actual heating surface ÷ volumn cylinders	310	261	259	219	209
Equated heating surface ÷ volumn cylinders	84.8	79.8	68.2	65.8	72.6
Grate area ÷ volumn cylinders	3.8	3.8	2.77	2.77	3.89
Length tubes in inches ÷ diameter in inches	111	100.5	117	99	80

TABLE II.

The general construction and arrangement of the combustion chamber can be seen by reference to the illustration showing the section of the boiler designed for the Pacific type locomotives. The ring forming the chamber is radially stayed from the boiler shell on the upper section, and is supported and stiffened by specially designed plates set longitudinally between it and the shell at the bottom and part way up the sides. The chamber has a clearance for circulation of 7½ ins. at the bottom, narrowing to 7 ins. at the closest point at the sides, which will probably prove to be sufficient to furnish the required circulation for the firebox side sheets and back head. The inner throat sheet meets the combustion chamber ring in a curve of long radius, and the brick arch occupies its usual position from the throat sheet diagonally upward.

Reference to the accompanying table I. will show the reduction of actual heating surface which the combustion chamber has made in both the Pacific and Mikado types. It is well known that a square foot of heating surface in the firebox is much more valuable than an equal area in the flues, and table II. is given showing various ratios with both actual and equated heating surface. Taking the Mikado type as an example, for in this case the number and location of the flues has not been changed and they have been shortened for the full length of the combustion chamber, it will be seen that its introduction has reduced the amount of tube heating surface from 3,798 sq. ft. to 3,192 sq. ft., or 16 per cent., and at the same time the firebox heating surface has been increased

WEIGHTS AND DIMENSIONS OF NORTHERN PACIFIC LOCOMOTIVES.

Type	Pacific	Pacific	Pacific	Mikado	Mikado	Prairie
Combustion chamber	Without	With	With	Without	With	With
Superheater	Without	Without	With	Without	Without	Without
Service	Passenger	Passenger	Passenger	Freight	Freight	Mixed
Fuel	Bit. Coal	Bit. Coal	Bit. Coal	Bit. Coal	Bit. Coal	Bit. Coal
Tractive power	31,000 lbs.	31,000 lbs.	31,000 lbs.	46,630 lbs.	46,630 lbs.	33,300 lbs.
Weight in working order	219,000 lbs.	223,000 lbs.	226,500 lbs.	259,000 lbs.	261,000 lbs.	209,500 lbs.
Weight on drivers	142,500 lbs.	146,300 lbs.	147,500 lbs.	196,000 lbs.	205,000 lbs.	152,000 lbs.
Weight of engine and tender in working order	347,000 lbs.	364,800 lbs.	368,300 lbs.	405,500 lbs.	438,800 lbs.	349,000 lbs.
Wheel base, driving	12 ft.	12 ft.	12 ft.	16 ft. 6 ins.	16 ft. 6 ins.	11 ft.
Wheel base, total	33 ft.	32½ ft.	32½ ft.	34 ft. 9 ins.	34 ft. 9 ins.	28 ft. 11 ins.
Wheel base, engine and tender	61 ft. 11 ins.	61 ft. 11 ins.	61 ft. 11 ins	63 ft. 1 in.	63 ft. 1 in.	57 ft. 3½ ins
CYLINDERS.						
Kind	Simple	Simple	Simple	Simple	Simple	Simple
Diameter and stroke	22x26 ins.	22x26 ins.	22x26 ins.	24x30 ins.	24x30 ins.	21x28 ins.
VALVES.						
Kind	Piston	Piston	Piston	Piston	Piston	Piston
Gear, type	S.	S.	S.	S.	W.	W.
Greatest travel	6 ins.	6 ins.	6 ins.	5⅝ ins.	5½ ins.	5½ ins.
Outside lap	......	1 in.	1 in.	......	1⅛ ins.	1⅞ ins.
Inside clearance	......	⅛ in.	⅛ in.	......	0	0
Lead in full gear	......	L. & L.	L. & L.	......	5-16 in.	5-16 in.
WHEELS.						
Driving, diameter over tires	69 ins.	69 ins.	69 ins.	63 ins.	63 ins	63 ins.
Driving, thickness of tires	3½ ins.	3½ ins.	3½ ins.	3¼ ins.	3¼ ins.	3¼ ins.
Driving journals, main, diameter and length	9½x12 ins.	9½x12 ins.	9½x12 ins.	10x12 ins.	10x12 ins.	9¼x12 ins.
Driving journals, others, diameter and length	9x12 ins.	9x12 ins.	9x12 ins.	9½x12 ins.	9¼x12 ins.	9¼x12 ins.
Engine truck wheels, diameter	33½ ins.	33½ ins.	33½ ins.	33½ ins.	33½ ins.	33½ ins.
Engine truck, journals	6x11 ins.	6x11 ins.	6x11 ins.	6½x12 ins.	6½x12 ins.	6½x12 ins.
Trailing truck wheels, diameter	45 ins.	45 ins.	45 ins.	45 ins.	45 ins.	45 ins.
Trailing truck, journals	8x14 ins.	8x14 ins.	8x14 ins.	8x14 ins.	8x14 ins.	8x14 ins.
BOILER.						
Style	E. W. T.	E. W. T.	E. W. T.	E. W. T.	E. W. T.	E. W. T.
Working pressure	200 lbs.	200 lbs.	200 lbs.	200 lbs.	200 lbs.	200 lbs.
Outside diameter of first ring	72⅛ ins.	72⅛ ins.	72⅛ ins.	75¾ ins.	75¾ ins.	72¼ ins.
Firebox, length and width	96x65¼ ins.	96x65¼ ins.	96x65¼ ins.	97x66 ins.	96x65¼ ins.	96x65¼ ins.
Firebox, water space	......	4½ & 4 ins.	4½ & 4 ins.	......	4½ & 4 ins.	4¼ & 4 ins.
Tubes, number and outside diameter	347-2 ins.	306-2 ins.	192-2 ins.	374-2 ins.	372-2 ins.	306-2 ins.
Tubes, superheater, number and diameter	......	......	24-5 ins.	......	......	......
Tubes, length	18 ft. 6 ins.	16 ft. 9 ins.	16 ft. 9 ins.	19 ft. 6 ins.	16 ft. 6 ins	13 ft. 3 ins.
Heating surface, tubes	3,339.4 sq. ft.	2,736.7 sq. ft.	2,196.37 sq. ft.	3,798 sq. ft.	3,192 sq. ft	2,105 sq. ft.
Heating surface, firebox	188.8 sq. ft.	241.7 sq. ft.	242.31 sq. ft	209 sq. ft.	245 sq. ft.	235 sq. ft.
Heating surface, total	3,528.2 sq. ft.	2,978.4 sq. ft	2,438.68 sq. ft.	4,007 sq. ft.	3,437 sq. ft.	2,340 sq. ft.
Superheater heating surface	......	......	341.15 sq. ft.	......	......	......
Grate area	43.5 sq. ft.	43.5 sq. ft.	43.5 sq. ft.	43.5 sq. ft.	43.5 sq. ft.	43.5 sq. ft.
Smokestock, diameter	18 ins.	18 ins.	18 ins.	20 ins.	20 ins.	18 ins.
Smokestack, height above rail	15 ft. 5½ ins	15 ft. 5½ ins	15 ft. 5½ ins	15 ft. 10½ ins	15 ft. 10½ ins	15 ft. 8½ ins
Center of boiler above rail						
TENDER.						
Tank	Water bottom	Water bottom	Water bottom	Water bottom	Water bottom	Water bottom
Frame	13-in. chan.	13-in. chan.	13-in. chan.	13-in. chan.	13-in. chan.	13-in. chan.
Wheels, diameter	33½ ins.	33½ ins.	33½ ins.	33 ins.	33 ins.	33 ins.
Journals, diameter and length	5½x10 ins.	5½x10 ins.	5½x10 ins.	5½x10 ins.	5½x10 ins.	5x9 ins.
Water capacity	6,000 gals.	7,000 gals.	7,000 gals.	8,000 gals.	10,000 gals.	7,000 gals.
Coal capacity	12 tons	12 tons	12 tons	12 tons	12 tons	12 tons

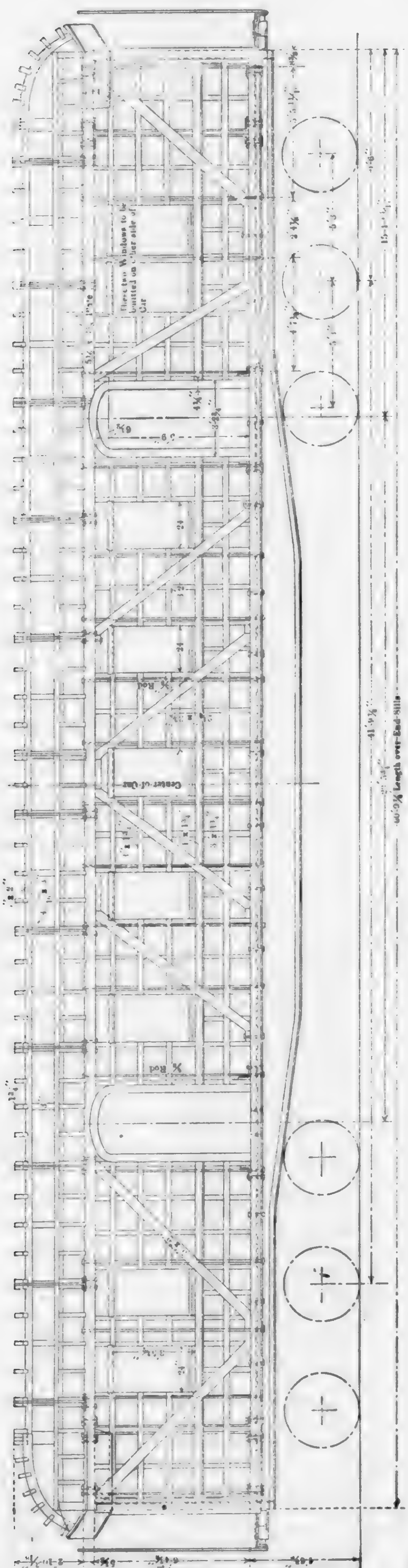
TABLE I.

from 209 sq. ft. to 245 sq. ft., an increase of 16.2 per cent. This increases the percentage of total heating surface in the firebox from 5.15 per cent. to 7.15 per cent. The firebox volume has been increased from approximately 260 cu. ft. to 322.5, or 24 per cent., and as this has all been added ahead of the brick arch it should aid materially in the thorough mixing and burning of the gases. By the formula derived by Mr. H. H. Vaughan from Petiet's experiments for the relative value of flue and firebox heating surface, which equates the total firebox heating surface to the total flue heating surface divided by the square root of the length of the flues in feet, we find that the total equated heating surface has been reduced but 39.4 sq. ft., or 3.7 per cent., which is undoubtedly more than offset by the improved combustion conditions. This being the case, it would appear that the steaming factors of the two boilers are on a par, and that there is a net gain of reduced flue leakage by the removal of the flue ends from the hottest part of the furnace; the opportunity to reduce back pressure by using a larger nozzle because of the shorter flues and the ability to work on the flues without removing the brick arch.

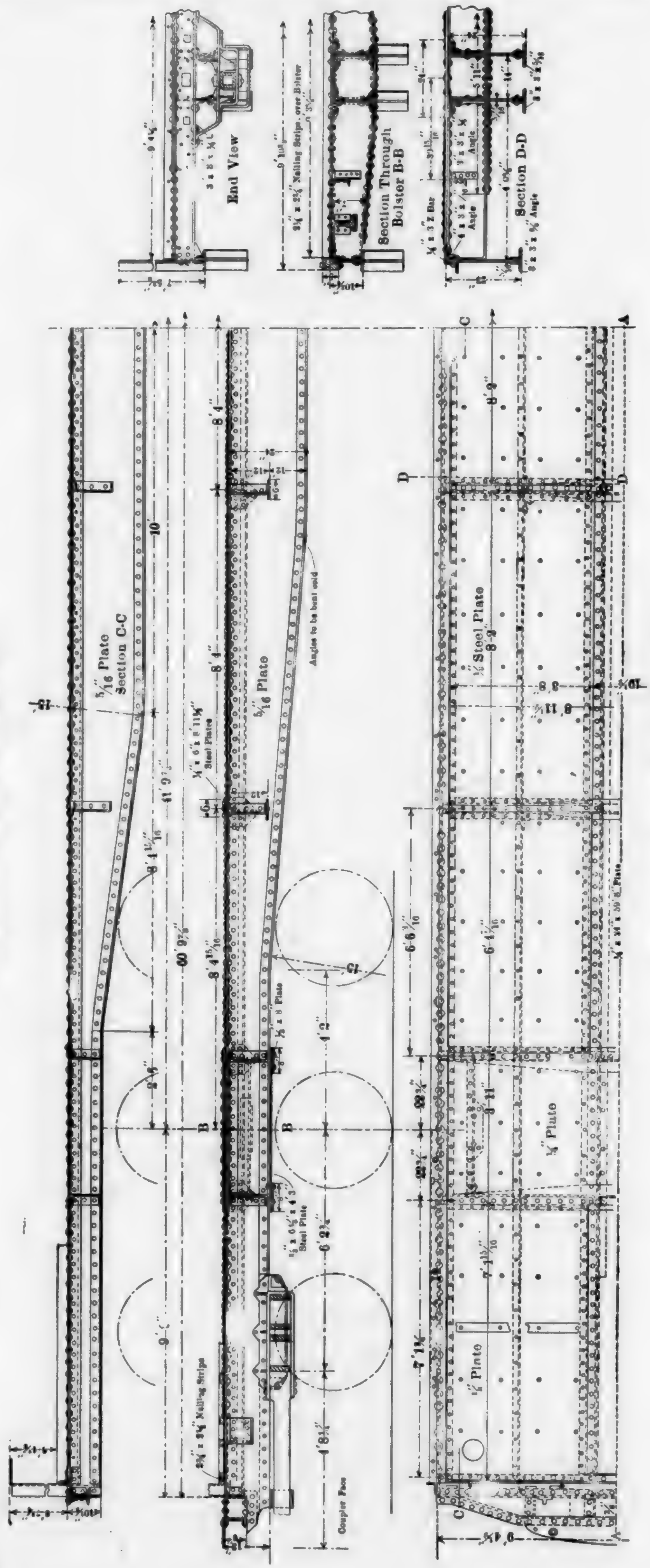
RAILROAD Y. M. C. A.—We also feel that we should say something as to how these men should be cared for at terminals, to improve their mental as well as social standing. We believe that good, clean rest rooms should be provided at terminals to encourage cleanliness with our men. We also believe that they should have access to reading rooms or libraries, where they can keep themselves posted on the leading topics of the day, mechanical and otherwise. Your chairman is fortunate enough to be employed on a road that has a Railroad Y. M. C. A. at each terminal. At one of the associations there is a large library, and members of any of the other associations can draw books from this library, the books being handled back and forth by the railroad company free of cost. At all of the associations there are good, clean rest rooms, and at several of the away-from-home terminals there are lunch rooms; and we would heartily recommend the Railroad Y. M. C. A. to any railroad, as we know of nothing that will improve the standard of the men, from a moral or social standpoint, more than the installing of these institutions.—*Report of Committee on "The Future Engineer," before the Traveling Engineers' Association.*

THE COST OF RAILWAY OPERATION.—The increase in the cost of railway operation is well shown by figures compiled by Mr. H. T. Newcomb. In 1899 it cost $856,968,999 to operate the railways of the United States; in 1903 the same expenses amounted to $1,257,538,862, an increase of $400,569,863. In 1899 railway labor, exclusive of salaried employees, received $481,264,109; in 1903 the same classes received $720,580,923, an increase of $239,316,814. In 1899 the fuel used by locotives cost $77,187,344; in 1903 it cost $146,509,031, an increase of $69,321,687. Comparing operating expenses with work done, it appears that in 1899 for every dollar expended for operation the railways were able to carry 17 passengers and 165 tons of freight one mile. In 1903 the passenger mileage for each dollar expended in operation amounted to 16.6 and the freight mileage to 138. Each $1 of operating expenses in 1899 brought in $1.53 in revenue, not including that from miscellaneous services, while in 1903 it brought in $1.38 only. —*The Engineering Record.*

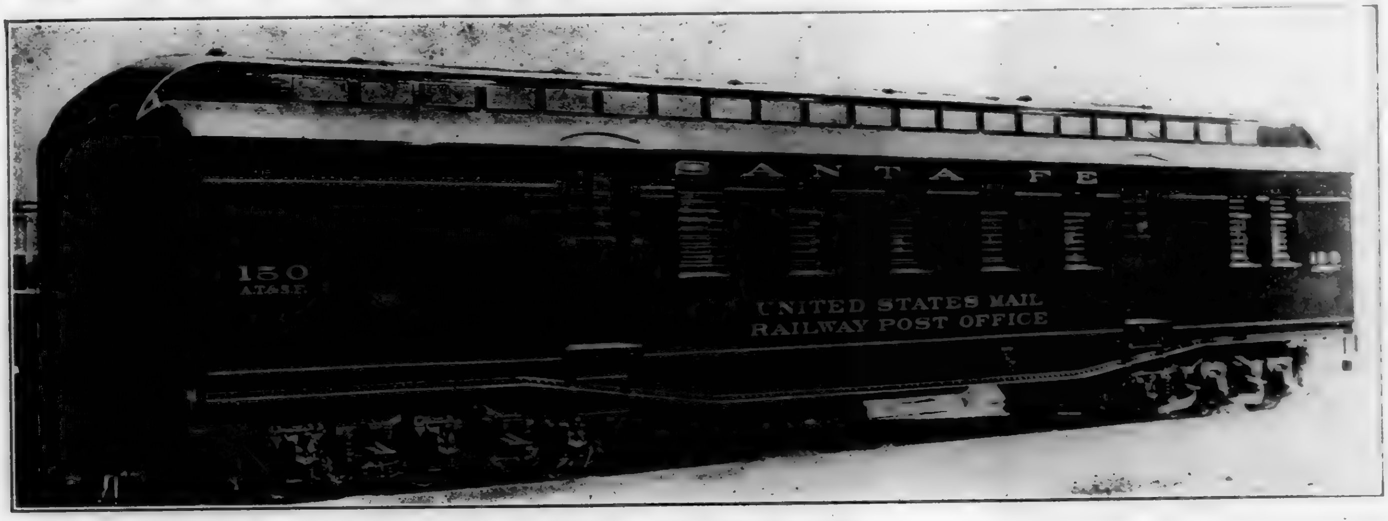
WATERPROOF GLUE.—A waterproof glue may be made from three parts of gum shellac and one part of India rubber, these being dissolved separately in ether under the influence of heat, and the two solutions mixed and kept for a time in a sealed bottle. Water, either hot or cold, and most acids and alkalies will have no effect on the glue.—*The Iron Age.*



SIDE FRAMING OF SANTA FE POSTAL CAR.



STEEL UNDERFRAME OF SANTA FE POSTAL CAR.



POSTAL CAR WITH STEEL UNDERFRAME—SANTA FE SYSTEM.

STEEL UNDERFRAME POSTAL CAR.

SANTA FE SYSTEM.

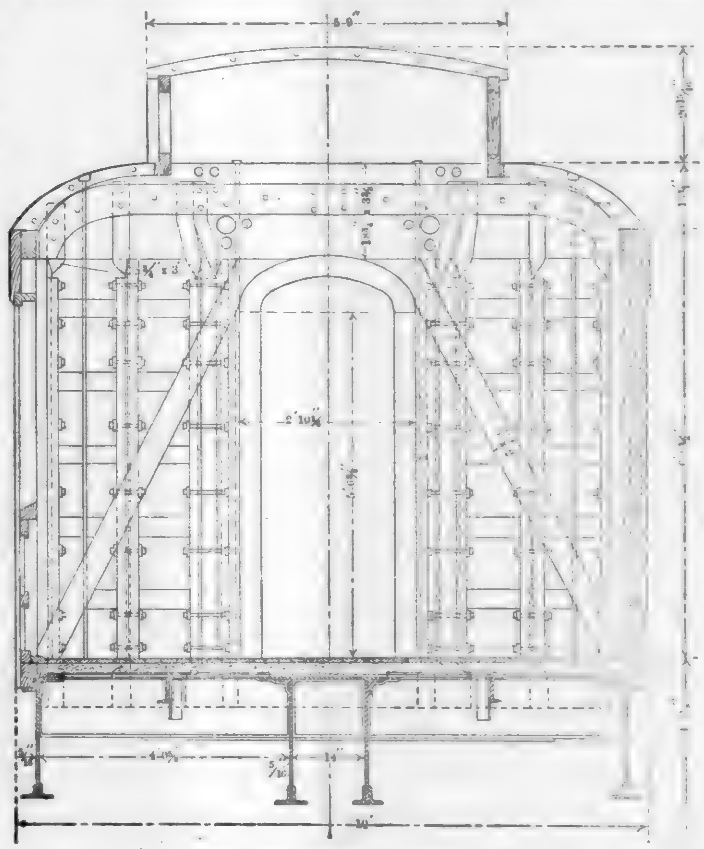
About a year ago the Santa Fe placed in service 39 steel underframe postal cars, which have given very satisfactory results since being placed in operation. The general dimensions of these cars are as follows:

Length over end sills	60 ft. 9⅞ ins.
Length inside	60 ft.
Width over sills	9 ft. 10⅜ ins.
Width inside	9 ft. 2 ins.
Height, top of floor to top of plate	6 ft. 9½ ins.
Height, floor to ceiling	9 ft. 4⅞ ins.
Height, top of rail to top of roof at center	14 ft. 3⅝ ins.
Weight, fully equipped, about	105,000 lbs.
Weight of steel underframe	20,000 lbs.

The center sills are continuous for the full length of the car, and consist of 5-16-in. open hearth steel plates reinforced at the bottom by two 3x3x5-16-in. angles, as shown, and at the top, on the outside only, by a 3x3x¼-in. angle. They are 24 ins. deep at the center for a distance of about 10 ft., tapering to 13 ins. at the bolster. They are covered by a ¼-in. steel plate 24 ins. wide and 59 ft. 8 ins. long, to which they are securely riveted. The side sills consist of 5-16-in. steel plates reinforced by two 3x3x⅜-in. angles at the lower edge and by a ¼x3-in. Z bar and a 4x3x5-16-in. angle at the top They are 23 ins. deep at the middle and 10⅛ ins. deep at the bolsters. A 3⅜x5-in. wood sill is supported by the Z bar, as shown on the drawing.

The space between the center and the side sills is covered by ⅛-in. steel floor plates riveted to the edges of the center sill cover plate and to the top angles of the side sills. In addition the floor plate is supported and stiffened by a 5-in., 6.5-lb. channel extending lengthwise and about halfway between the center and side sills. Nailing strips, 2¼x2¾ ins., are bolted to the floor plate by ½-in. bolts. The four sills are securely tied transversely by pressed steel diaphragms ¼ in. thick. These diaphragms are reinforced at the top by ¼x6-in. steel plates extending the full width of the car, and are stiffened and tied at the bottom by ¼x6-in. plates 5 ft. 11 ins. long, which pass through openings cut in the webs of the center sills and are riveted to the lower edges of the diaphragms.

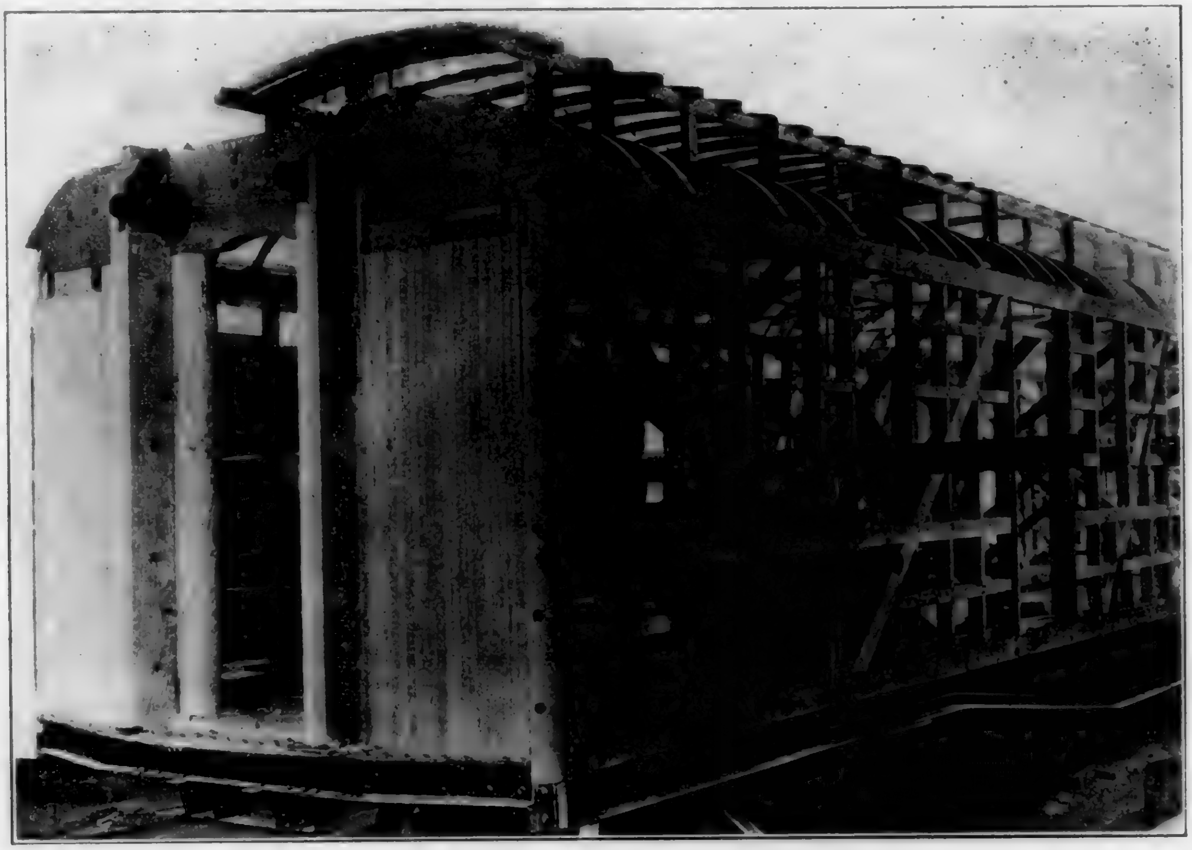
The body bolster is formed of two pressed steel diaphragms ⅜ in. thick, with the flanges turned outward, and spaced 3 ft. 6 ins. back to back. These diaphragms are riveted to the center and side sills, and each set is tied at the bottom similar to the cross ties, except that the plates widen to 8 ins. where they are riveted to the center sills. The entire bolster



END FRAMING OF POSTAL CAR.

is covered with a ¼-in. plate 4 ft. 3 ins. wide by 8 ft. 11 ins. long, which is riveted to the tops of the diaphragms and to the center and side sills by ¾-in. rivets. The center plates are of cast steel, and the side bearings are of hardened steel plate riveted to the bottom flange of the 7-in. channel extend-

STEEL UNDERFRAME OF POSTAL CAR.



FRAMING OF SANTA FE POSTAL CAR.

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The webs and top flanges of the center sills are cut away at the ends to a depth of 6 ins. and in line with the ends of the side sills. A 6-in., 10.5-lb. channel is secured across the ends of the sills with flanges in and with its back 11 ins. from the end of the center sills. The end sill consists of this member and a bent 6-in., 8-lb. channel, 7 ins. from it and parallel to it for a distance of 4 ft. 10 ins. These two channels are tied together by four pressed steel diaphragms, two of which are in line with the center sills. The ends of the outer channel bend back to meet the inner channel at the side sills. These end sill channels are riveted to the center sill cover plate, and a heavy cast steel buffer beam is secured to them. A wooden sill for attaching the underframe is secured to a 2½x2½x5-in. angle riveted to the tops of the longitudinal sills back of the end sill.

Yellow pine flooring ⅞ ins. thick is secured to the nailing strips, which are bolted to the floor plate, and the space between this and the sub-floor is packed with mineral wool.

The side posts are 2¼x3⅜ ins., and the first and third posts from the end of the car are plated on both sides with ⅜x2½-in. iron. The corner posts are secured to the corner angle by ½-in. bolts. The post rods are ⅝ in. in diameter with the nuts riveted over. The end posts consist of 2¼x4⅛-in. long leaf yellow pine, and are plated on both sides with ¾x3-in. iron. The iron carlines, 12 in number, are ¾x2 ins., the T foot being secured to the side plates with ½-in. bolts.

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DISCIPLINE IN THE BLACKSMITH SHOP.*

By A. W. McCaslin.

We cannot discipline others if our own education along the same line has been neglected; neither can we secure and retain in our shops sober, honest, industrious, right-thinking men, and live in opposition to right principles ourselves. We are seen as we are; either irritable, untruthful, intemperate, profane, unscrupulous, or affable, truthful, clean-mouthed, appreciative, progressive, fair-minded.

Discipline does not mean gruffness, harshness, or a long face and knitted brow; but rather the reverse, and, when accompanied with the right spirit or proper understanding is generally productive of a kindly feeling between the foreman and the workman.

We cannot have discipline without system; we cannot have a good system without classification; we cannot have classification of the work without classification of the men; we cannot classify either the men or the work without a thorough practical knowledge of our business. These qualifications or requisites are only attainable through an experience that includes the solving of each problem in shop requirements correctly as it is presented to us; and through the ability to read human nature and readily distinguish the character of men, not only in their aptitude toward mechanics generally, but in their disposition as well, whether optimistic (with the resultant upbuilding influence on associates and fellow-workmen) or the opposite, that is, pessimistic; a word that causes one to feel like rinsing his mouth after speaking it.

Classification of the work makes the workman responsible for, and consequently much more careful with his work. While it is necessary that a certain number of items or pieces be made in a certain number of hours, they should be made perfect. When a certain number of articles are produced by one workman, and a duplicate order by another, the responsibility of failure or breakage while in service is not easily placed. This fact is frequently taken advantage of in the use of the fuller, or hammer pean, to hide defects that the fore-

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To have a good system we must have uniform or established methods of production. This is one of the fundamental necessities to the greatest and best output in any railway shop, and will help to remove thoroughly the cause for any foreman having to exaggerate at home or abroad as to the output of his shop. And if we do not exaggerate, the other fellow will have less inducement to "stretch" matters a little farther in his pneumatic efforts to exceed, and this would keep us all out of trouble with our veracity unscarred.

MAKING GOOD SMITHS.

The best interests of the company are served by making our own blacksmiths either by apprenticeship or by promoting bright, ambitious helpers. The writer's experience has led him to prefer the latter as the best material from which to make profitable blacksmiths for the company, and at the same time help those who are anxious to help themselves and serve their employers.

In promoting helpers we have our pick and choice from many who have already given evidence of making just such men as we need to handle the work in a smith shop. And I wish to say, while on this subject, for the benefit of those whose business it is, that when these men educated in our shops become first-class workmen, they should receive first-class wages and not be permitted to accept a position elsewhere for the sake of ten or fifteen cents per day, while a stranger, an inferior workman, is given the position and the rate of pay the other man could not obtain.

Very seldom are the tools and mehods of working in other shops such as would, if adopted, improve our own best method of operating our shop. Please understand this correctly; we do not mean to say that the perfect system in the small shop would answer as a perfect system in the larger shop; neither would the perfect system in the large shop be the best or most profitable in the small shop. These facts are the arguments in favor of making our own workmen, for as a rule workmen educated under a system differing from our own are not profitable to the company nor to themselves until they become acquainted with the tools and methods of working in our particular shop—quality and quantity of output considered. Yet, when the exception to this rule occurs, and it does sometimes, though infrequently, dividends are increased through the better methods of production; this point is only one of the many that should be promptly recognized by the wideawake foreman who wishes to operate his shop successfully. Better ideas of others should not escape us, while ideas of less merit than our own should be disregarded.

The following are also a few of the arguments in favor of making and retaining our own workmen: they know the foreman, his disposition, ambition, etc., and are unconsciously governed accordingly; while the foreman does not only know the dispositions and abilities of his own men, but recognizes their weak points as well, and in helping them overcome these makes them better men to themselves as well as better and more profitable men for the service of the company. They (our own men) know every tool in the shop, know where it is kept and have used or seen it used; they know the established daily output of the tool or tools and again are governed accordingly. We will also have less labor trouble with men educated in our own shop than with the itinerant mechanic whose employment may make a parallel to the case of one rotten apple spoiling every other apple in the barrel. In explanation and qualification of the last statement, will say, if we engage several workmen from as many different shops, permitting each one to bring with him the discipline, time for doing the work and the ideas of quality that govern these points in the shop each one came from, our shop system will speedily become demoralized.

SPECIAL MACHINES.

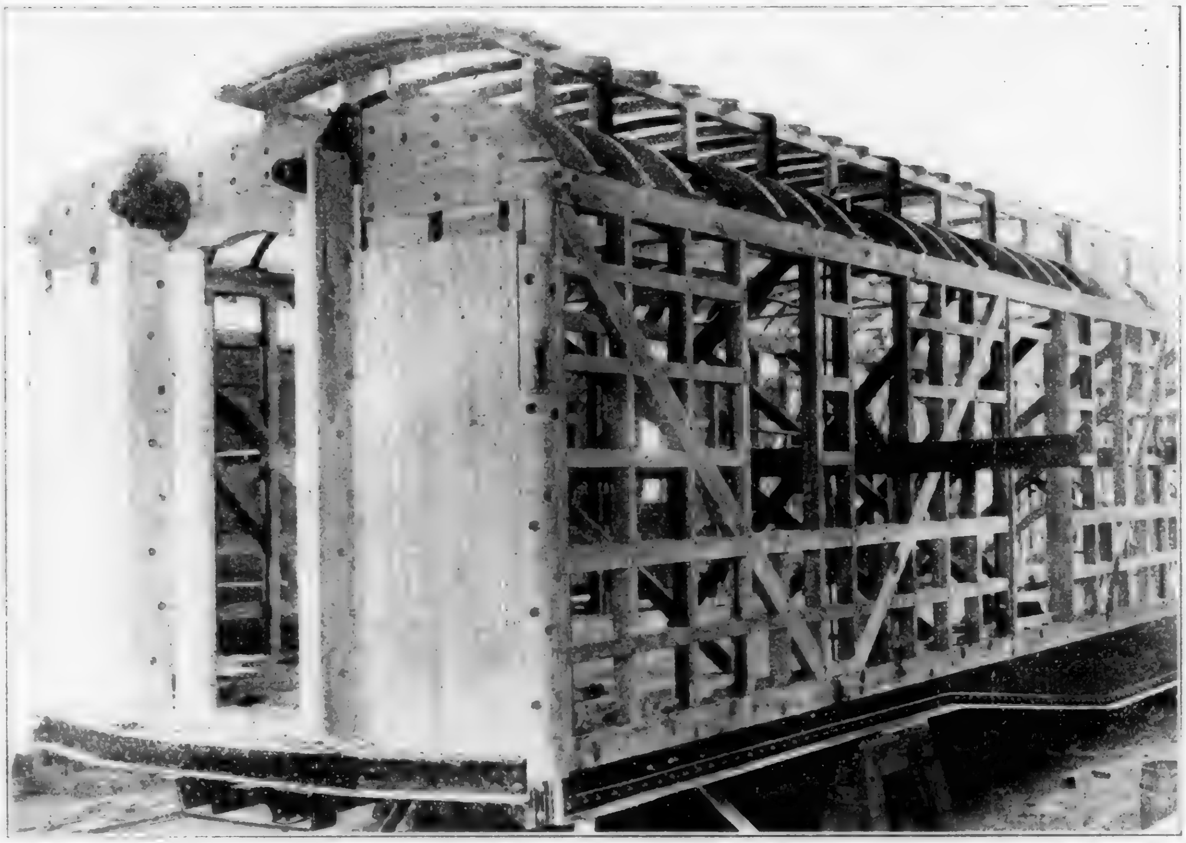
We frequently hear foremen in the medium or small shops complain that they cannot compete in the cost of output with the large shops that have special machines with which to do their work. Yet they do not have to meet the prices of the special machine men on special work to be equally as profitable to their companies. In large shops on large systems where the different items are made by the thousands to supply all the repair points with the necessary material, special machines are profitable and necessary, but in the small or medium shop there are generally just enough men to take care of the jobbing or running repairs when the demands are greatest. This demand is not constant or regular. The requirements of to-day call for our best efforts and no false movements; to-morrow there will not be sufficient repair work to keep the men employed at the same speed as yesterday, and every man that can be spared from the repair work at any time should be placed immediately on the special or new work with such tools as we may have, the steam hammer and possibly one or two other machines. It would not be very profitable to install costly special machines in such cases with which to produce the work while slackening speed or letting the men rest or kill time until another rush of repair work called for more activity.

Without system and much thought in the allotment of work for bulldozers, heading machines, etc., there will be much time lost. Orders for items to be produced by machines should be large enough to try the capacity of the machine for at least one-half day or one or two full days, sufficient to meet all demands for that item in the next thirty days. All similar work should follow in turn, avoiding as much as possible the most complicated tools as well as the changing of furnaces. We recognize the fact that with special machines new work may often be produced for less money than the old item can be repaired. Yet, on most or many of our railroads, the repairs to foreign cars is quite an item, and it would be impossible, at least not profitable, to have machines for producing this class of work in the new, there being scarcely two duplicate pieces called for in the same day.

Admiral Togo's victories were not won by a preponderance of armament, but by superiority of skill. It is not in the possession of a surplus of special or individual power machines alone that our success and the success of our shop depend, but rather in our brain power or ability to supply a limited number of power machines with sufficient easily adjustable formers, dies, etc., so that each machine may be utilized for a multitude of purposes.

To obtain the best results in the railway smith shop, or in fact in any shop, there are many things the foreman should not do which are almost equal in importance to the things he should do. He should not be gruff with his men; he should not have those who are termed "pets" in his shop; neither should he show partiality; he should not speak lightly of any one of his men to another, or even to make possible inference to his discredit, for such a thing is one of the meanest ways of taking advantage of another. The foreman should not try to force impossible results from his workmen, for they will invariably lose confidence in his ability and judgment; neither should he in dealing with his men handle the truth carelessly.

Finally, and in that same old much abused "nutshell," regardless of the particular system under which the smith shop or any other shop is operated, it is absolutely necessary in order to obtain the best results that the foreman prove convincingly to his workmen that he is perfectly familiar with what constitutes proper results in one hour's or one day's work on any item or items given them to do. If this ability in the foreman, gained through an abundance of both experience and common sense, is recognized by the workmen, either voluntarily or through force, there will be no necessity to change the present system or mode of operation to obtain the best results.



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In promoting helpers we have our pick and choice from many who have already given evidence of making just such men as we need to handle the work in a smith shop. And I wish to say, while on this subject, for the benefit of those whose business it is, that when these men educated in our shops become first-class workmen, they should receive first-class wages and not be permitted to accept a position elsewhere for the sake of ten or fifteen cents per day, while a stranger, an inferior workman, is given the position and the rate of pay the other man could not obtain.

Very seldom are the tools and methods of working in other shops such as would, if adopted, improve our own best method of operating our shop. Please understand this correctly; we do not mean to say that the perfect system in the small shop would answer as a perfect system in the larger shop; neither would the perfect system in the large shop be the best or most profitable in the small shop. These facts are the arguments in favor of making our own workmen, for as a rule workmen educated under a system differing from our own are not profitable to the company nor to themselves until they become acquainted with the tools and methods of working in our particular shop—quality and quantity of output considered. Yet, when the exception to this rule occurs, and it does sometimes, though infrequently, dividends are increased through the better methods of production; this point is only one of the many that should be promptly recognized by the wideawake foreman who wishes to operate his shop successfully. Better ideas of others should not escape us, while ideas of less merit than our own should be disregarded.

The following are also a few of the arguments in favor of making and retaining our own workmen; they know the foreman, his disposition, ambition, etc., and are unconsciously governed accordingly; while the foreman does not only know the dispositions and abilities of his own men, but recognizes their weak points as well, and in helping them overcome these makes them better men to themselves as well as better and more profitable men for the service of the company. They (our own men) know every tool in the shop, know where it is kept and have used or seen it used; they know the established daily output of the tool or tools and again are governed accordingly. We will also have less labor trouble with men educated in our own shop than with the itinerant mechanic whose employment may make a parallel to the case of one rotten apple spoiling every other apple in the barrel. In explanation and qualification of the last statement, will say, if we engage several workmen from as many different shops, permitting each one to bring with him the discipline, time for doing the work and the ideas of quality that govern these points in the shop each one came from, our shop system will speedily become demoralized.

SPECIAL MACHINES.

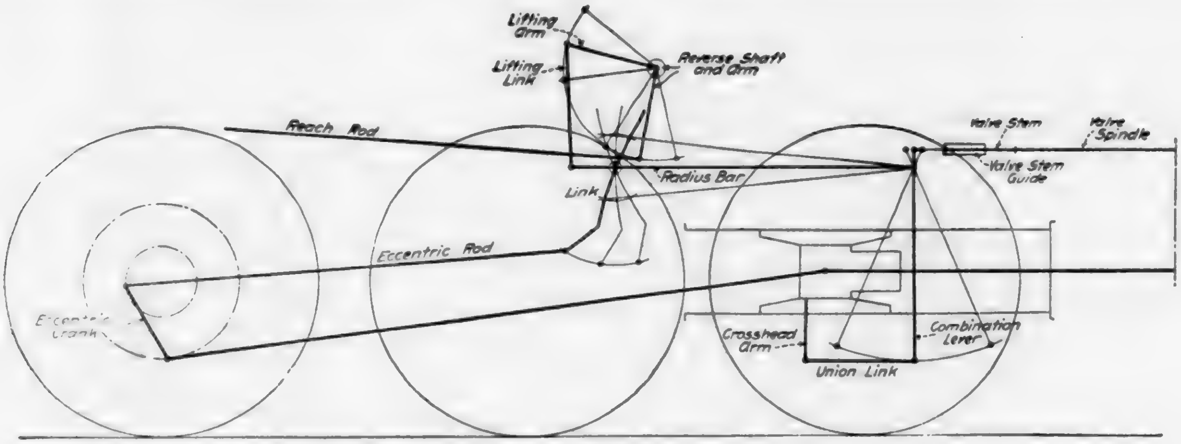
We frequently hear foremen in the medium or small shops complain that they [illegible] of output with the large shops that have special m[illegible]h which to do their work. Yet they do not hav[illegible] prices of the [illegible] is profit- [illegible] where the different items a[illegible] material. supply all the repair p[illegible] special machines are profita[illegible] out in the small or medium shop there are g[illegible]nough men to take care of the jobbing or ru[illegible] when the demands are greatest. Th[illegible] regular The requirements of to-da[illegible] and no false movements; to-morrow there will [illegible] work to keep the men employed at the s[illegible] day, and every man that can be spared from [illegible]ir wor[illegible] at any time should be placed immedia[illegible]ecial or new work with such tools as we may h[illegible]m hammer and possibly one or two other machines[illegible]uld not be very profitable to install costly special ma[illegible] in such cases with which to produce the work while slackening speed or letting the men rest or kill time until another rush of repair work called for more activity.

Without system and much thought in the allotment of work for bulldozers, heading machines, etc., there will be much time lost. Orders for items to be produced by machines should be large enough to try the capacity of the machine for at least one-half day or one or two full days, sufficient to meet all demands for that item in the next thirty days. All similar work should follow in turn, avoiding as much as possible the most complicated tools as well as the changing of furnaces. We recognize the fact that with special machines new work may often be produced for less money than the old item can be repaired. Yet, on most or many of our railroads, the repairs to foreign cars is quite an item, and it would be impossible, at least not profitable, to have machines for producing this class of work in the new, there being scarcely two duplicate pieces called for in the same day.

Admiral Togo's victories were not won by a preponderance of armament, but by superiority of skill. It is not in the possession of a surplus of special or individual power machines alone that our success and the success of our shop depend, but rather in our brain power or ability to supply a limited number of power machines with sufficient easily adjustable formers, dies, etc., so that each machine may be utilized for a multitude of purposes.

To obtain the best results in the railway smith shop, or in fact in any shop, there are many things the foreman should not do which are almost equal in importance to the things he should do. He should not be gruff with his men; he should not have those who are termed "pets" in his shop; neither should he show partiality; he should not speak lightly of any one of his men to another, or even to make possible inference to his discredit, for such a thing is one of the meanest ways of taking advantage of another. The foreman should not try to force impossible results from his workmen, for they will invariably lose confidence in his ability and judgment; neither should he in dealing with his men handle the truth carelessly.

Finally, and in that same old much abused "nutshell," regardless of the particular system under which the smith shop or any other shop is operated, it is absolutely necessary in order to obtain the best results that the foreman prove convincingly to his workmen that he is perfectly familiar with what constitutes proper results in one hour's or one day's work on any item or items given them to do. If this ability in the foreman, gained through an abundance of both experience and common sense, is recognized by the workmen, either voluntarily or through force, there will be no necessity to change the present system or mode of operation to obtain the best results.



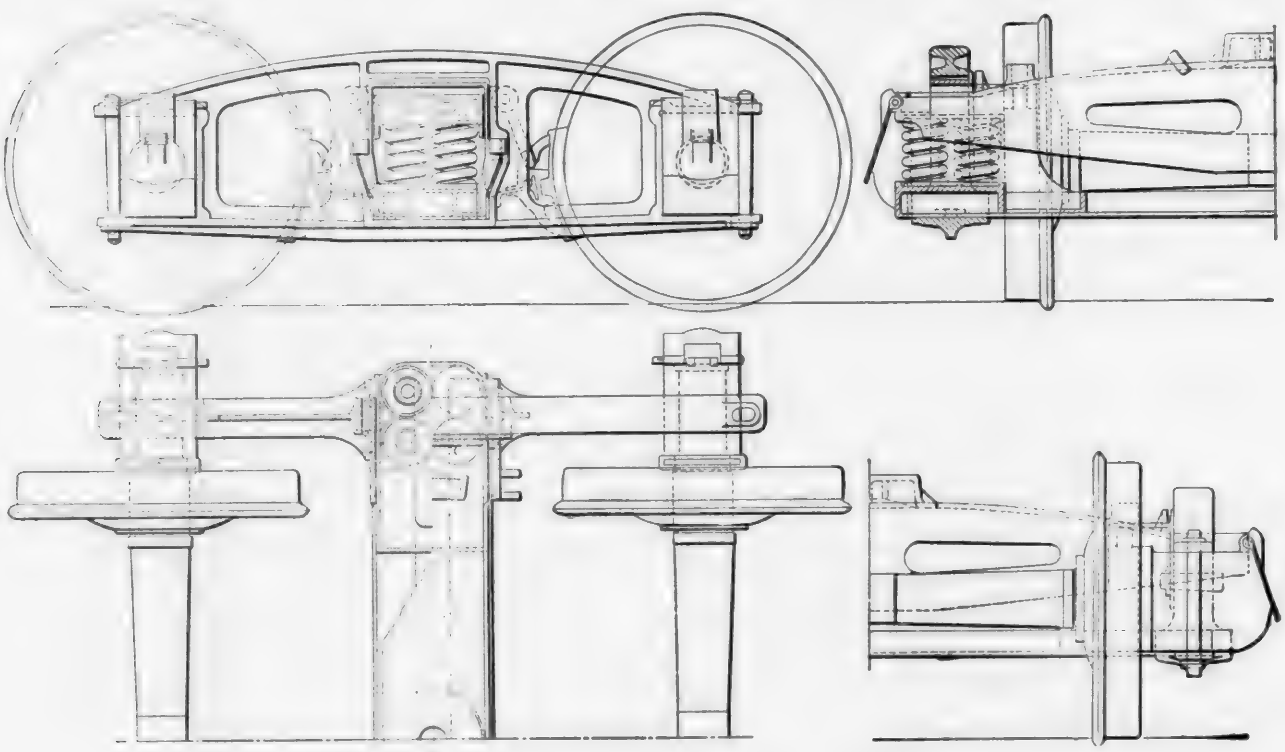
OUTLINE DIAGRAM OF WALSCHAERT VALVE GEAR.

(The names of the parts of the Walschaert valve gear, as designated above, have been adopted as standard by the American Locomotive Company. In view of the extending use of this gear and the various names which have been used to designate different parts, it seems advisable to have a uniformity in this respect and the AMERICAN ENGINEER AND RAILROAD JOURNAL has decided to use the names as given above.)

BOLTLESS CAST STEEL FREIGHT TRUCKS.

In 1902 Mr. W. E. Symons, at that time superintendent of motive power of the Plant System, placed in service a number of boltless cast-steel freight car trucks of his own design. These, although of very simple design and of great strength, did not prove flexible enough for the conditions under which they were used. Mr. Symons has recently redesigned these trucks, as shown in the accompanying drawings, to better adapt them to meet service requirements.

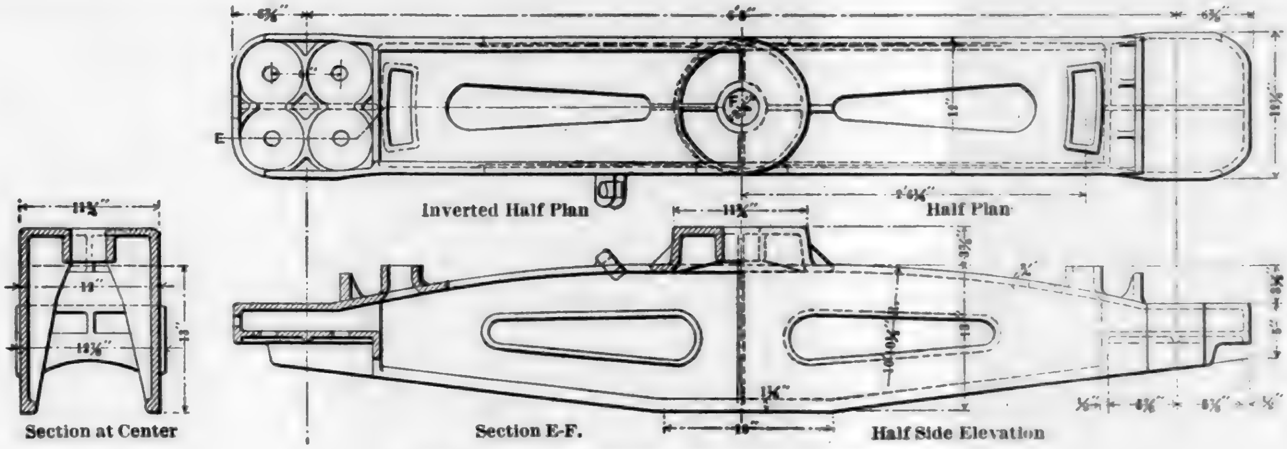
The side frame, of cast steel, is formed in one piece; the longer or horizontal leg of the angle has a 1⅜-in. hole 4½ ins. from each end, which fits over bosses cast on the lower bar of the side frames. The spring seat is of cast steel and is slipped in place from the inside of the frame and rests on the two spring plank angles, fitting between the vertical legs and having a lip on the outer side which extends down over the ends of the angles and comes flush with the lower bar of the side frame. The spring seat, which is shown in detail and from which the brake hangers are suspended, is rigidly secured to the side frame by two wrought iron keys driven between it and the sides of the columns. The lower



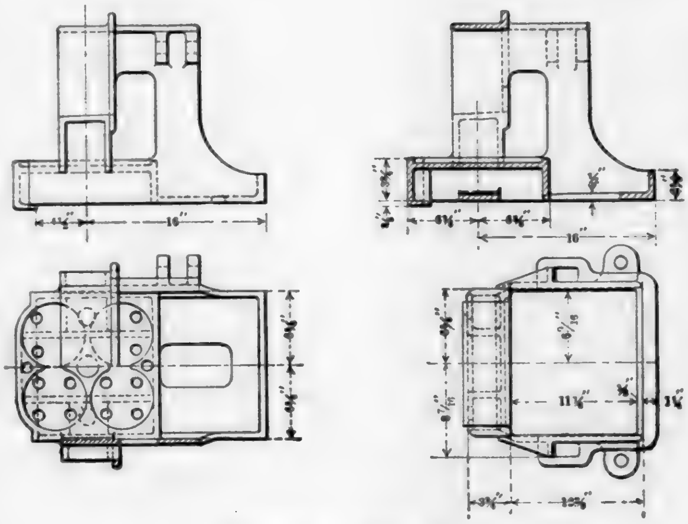
SYMON'S PIONEER BOLTLESS CAST STEEL FREIGHT TRUCK.

journal box jaws are horizontal, and the boxes are retained by heavy wrought iron, semi-circular keys, as shown. Provision has been made for using standard M. C. B. journal boxes, although this is not shown on the drawing. On the earlier design of trucks a one-piece cast steel spring plank was used, but it was found advisable, both because of the reduced weight and the greater flexibility, to use two 5 x 3 x ⅜ in. 9.8-lb. angles, with the shorter legs up, for this purpose. The angles are still, however, sufficiently flexible to insure freedom from derailment or injurious strains due to an undulating track or poor roadbed. No bolts are used in the construction of the truck and all keys are fitted with cotters.

part of this casting, which fits between the spring plank angles, extends inward from the side frame almost 14 inches, thus stiffening the connection of the angles to the side frame and preventing the side frames from getting out of alignment.



TRUCK BOLSTER—PIONEER CAST STEEL TRUCK.



DETAILS OF SPRING SEAT.

Mr. Symons has also brought out another design, in which the spring seat is cast integral with the side frame, thus eliminating the keys and reducing the weight. Openings for the spring plank angles are cored out below the spring seat, and each angle is riveted at each end of the side frame by three rivets, so placed that they may be removed from either the outside or the bottom of the truck.

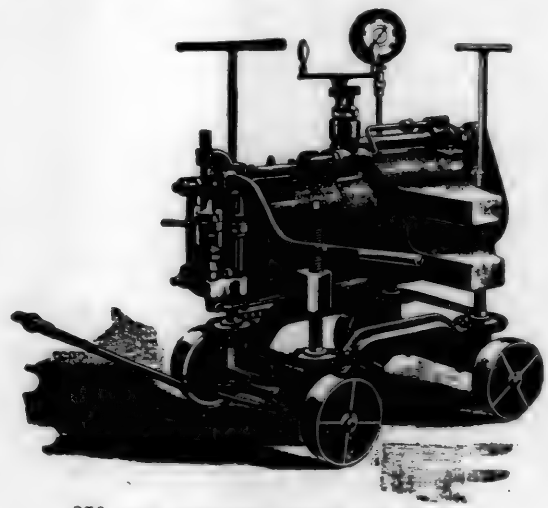
The truck bolster is of cast steel, with the center plates and side bearings cast integral with it. Reference to the drawing will show that the center plate is placed the reverse of that ordinarily used. The truck of this design, for use under 50-ton cars, will weigh approximately 1,690 lbs., including the bolster, which weighs 550 lbs. These trucks have been patented by Mr. Symons and will be manufactured by the Pioneer Cast Steel Truck Company of Chicago, of which he is the president.

250-TON PORTABLE CRANK PIN PRESS.

An exhibit which attracted more than usual attention at the Atlantic City conventions was that of the Butler Drawbar Attachment Company, of Cleveland. A new design of crank pin press made by the Watson-Stillman Company, of New York, was used for testing the Piper friction draft rigging, which was so arranged that the action of the spring and friction parts could be very closely observed as the pressure was increased until they practically came solid under a pressure of 350,000 lbs. The press was used so successfully for this purpose that it has been suggested that it would not only prove of value for use in railroad shop work, but might be used to considerable advantage by railroad companies wishing to test the different types of draft rigging.

The press, which is equipped with a double pump and a reversing cylinder, has a capacity of 250 tons, and is probably the most powerful portable shop tool of this kind that has ever been built. The large ram is operated by a double plunger pump, the low-pressure piston driving it forward at four times the speed of the high-pressure one, and giving a maximum pressure of 60 tons. A small cylinder for withdrawing the large ram is located above the larger cylinder, and the ram for this is connected to the larger one. A pair of geared screw valves throws the pump delivery to either the pressure or the return cylinder, as may be desired.

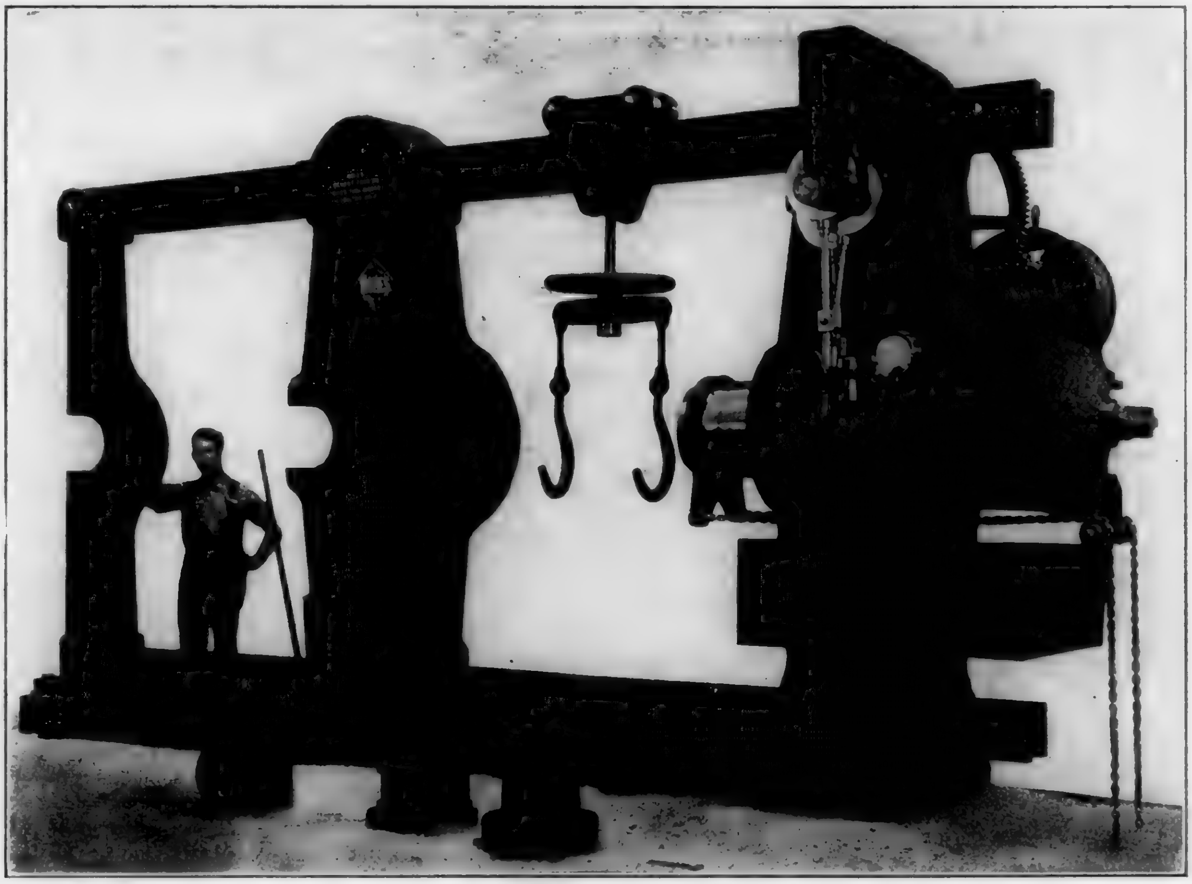
The entire tool may be raised or lowered by using a socket wrench on any one of the four elevating screws; or, if de-



250 TON PORTABLE CRANK PIN PRESS.

sired, the chain may be taken off and each screw be operated independently. The beam and cylinder are made of steel and in one piece, in order to secure lightness. The rod centers are adjustable from 23 to 52 ins., the diameter of the attaching rods being assumed at 4 ins. The center of the large ram is adjustable vertically from 20 to 32 ins. The shipping weight of the machine is about 2,600 lbs.

Chicago's Freight Tunnel.—About 45 miles of the tunnel is now completed, several branches extending well beyond the river on the north and west sides. The present equipment consists of 67 electric locomotives and 400 freight trucks. There are being built an additional complement of 15 locomotives and 250 trucks. The company has 40 receiving stations and is connected with nine regular railroads. The roads now ready for service are the Erie, Alton, Rock Island, Wabash, Santa Fe, Great Western, Monon, Baltimore and Ohio, Chicago, Milwaukee and St. Paul, and contracts have just been entered into between the tunnel company and the Chicago and Eastern Illinois and the Illinois Central.



NILES 600-TON HYDRAULIC WHEEL PRESS.

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A few years ago a 300-ton wheel press was considered to be sufficiently powerful for all purposes. With the introduction of cast steel driving wheel centers and the use of larger axles under the heavier power it soon proved unsatisfactory, and a more powerful machine was found necessary. Its successor, the 400-ton press, has also been found of insufficient capacity on roads where cast steel wheel centers and axles with wheel fits as large as 10 ins. in diameter are in use, and at the present time there is a demand for a much more powerful machine.

Inquiry among a dozen representative shop superintendents brought out the following facts: Three of them advised that they considered a 400-ton press of sufficient capacity. On one of these roads, however, the pressure required for pressing on driving wheels was considerably less than that used on other roads. Of the other two, one was from a shop where the locomotives are not very heavy, but of average capacity, and this is apparently true of the other one, for a shop superintendent at the other end of the same system, which is a large one, strongly advises the use of a 500 or 600-ton press, and gives some first-class reasons for doing so.

The other nine shop superintendents recommend a capacity of 500 or 600 tons. In one shop an old driving wheel press has been weighted down so that a pressure of 500 tons may be obtained, but in a number of instances it has been found impossible to press the wheels off with this pressure, and it is either necessary to heat the wheel center or to drill the axle or wheel center. In another shop, where a 300-ton wheel press is in use, it has been found impossible, in a majority of cases, to press off the wheels without first applying a gasolene heater. In another shop, where a 300-ton wheel press is in use, which exerts a maximum pressure of 350 tons, it has been found necessary in a great many instances to use the maximum pressure in order to press wheels off of axles with a 9¼-in. wheel fit, and it is estimated that with new power, having axles with a 10¼-in. wheel fit, it will be found necessary to use pressures as high as 450 to 500 tons. In another shop having a 300-ton wheel press it is quite frequently necessary to partially drill out the axle in order to remove the wheels, and the shop superintendent is of the opinion that the wheel press should have a capacity of 500 to 600 tons. In another shop it has in several instances been found necessary to use a pressure of 450 tons and then to start the wheels with a sledge.

The illustration shows a 90-in., 600-ton Niles hydraulic wheel press, which has recently been placed on the market. The distance between the ram and the resistance post, which is a steel casting, is 8 ft. 3 ins. Four tension bars are used instead of two, and the post is so arranged that its weight is entirely removed from them. The cylinder is of cast steel, and has an outside diameter of 27 ins. The pump has three plungers, and is operated by a 12½-h.p. motor. The machine will take wheels 84 ins. in diameter on the tread, the height between the tension bars being 90 ins.

The machine is mounted on a base plate, but no strains are transmitted to it, as all the pressure is taken by the tension bars. The cylinder is lined with copper expanded into place and burnished. The piston is packed with leather, is tight, durable, and causes very little friction. The ram is counterweighted for a quick return when the release valve is open. The safety valve may be set to open at any desired pressure, and is protected from tampering by a lock box. The pressure gauge is graduated for tons of pressure and for pounds per square inch on the ram. The water tank is bolted underneath the cylinder, taking the discharge and supplying the pumps.

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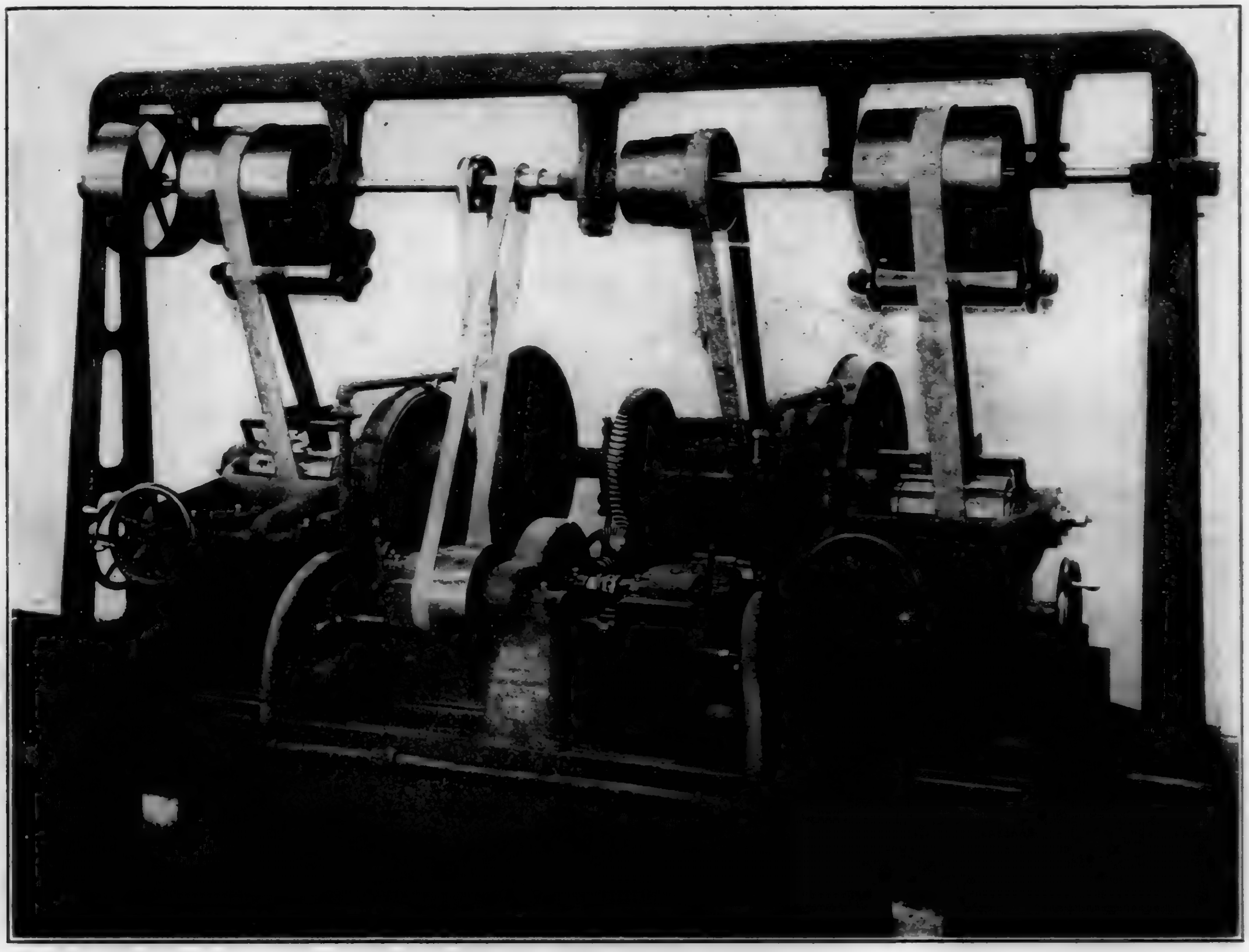
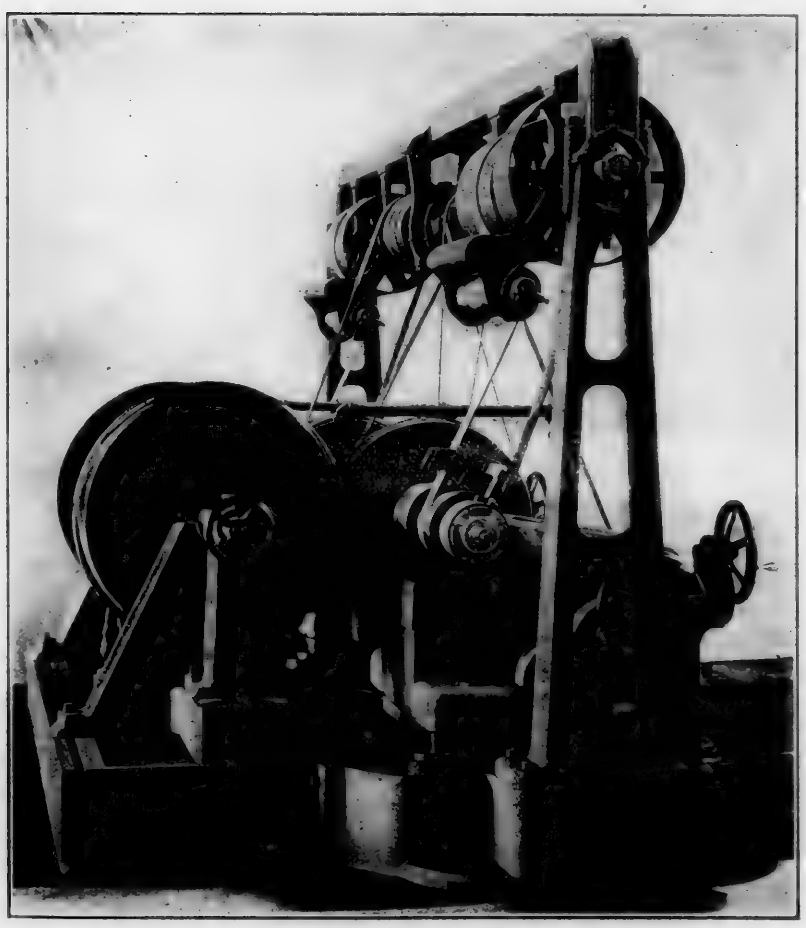


NORTON CAR WHEEL GRINDER—FRONT VIEW.

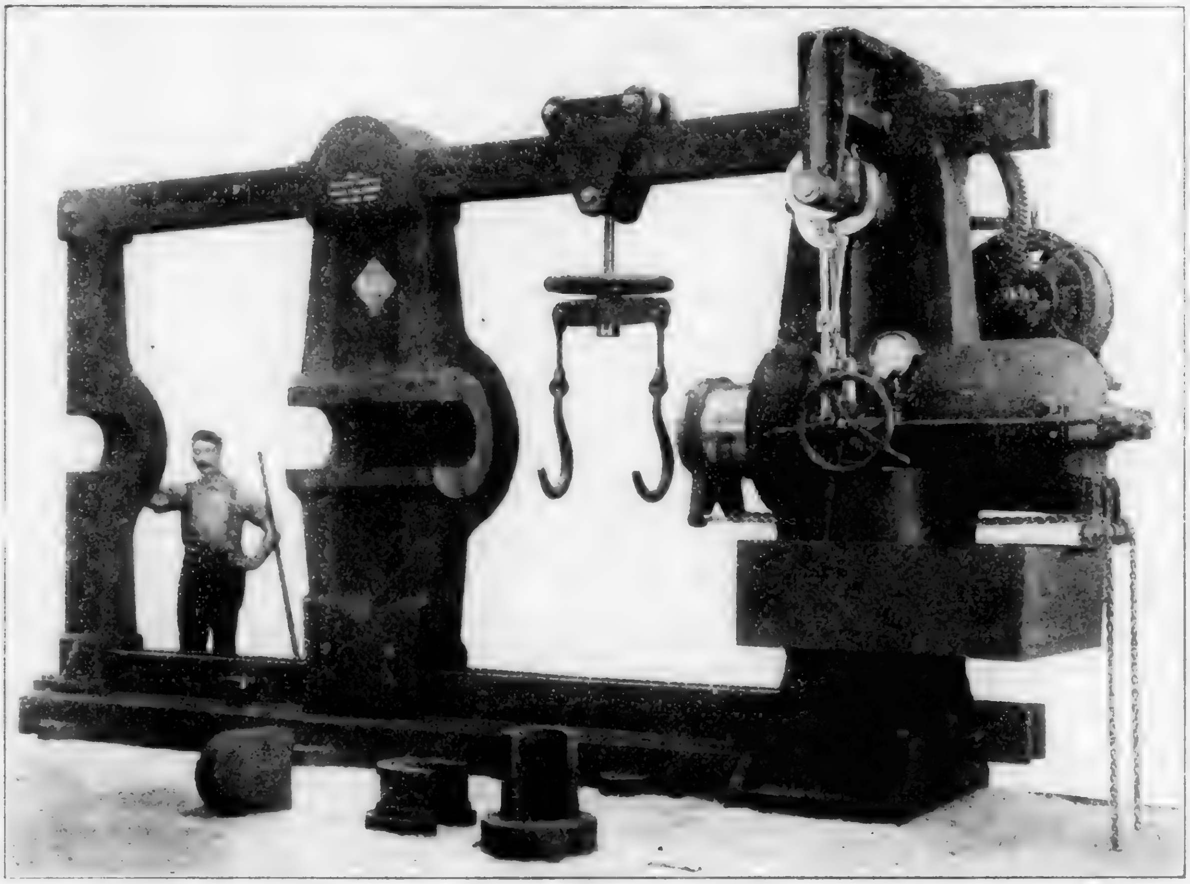


NORTON CAR WHEEL GRINDER—END VIEW.

CAR WHEEL GRINDER.

The Norton Grinding Company, Worcester, Mass., has recently furnished one of the large railroads with two car-wheel grinders of a new design. The new machine is of very substantial design, being built for accuracy and durability, and will grind the car wheels commercially with an error in roundness and concentricity of probably not over .002 to .003 in.

The car wheels and axle are driven from the center of the axle by a worm and worm wheel, an opening being left in the revolving journal of the worm wheel and a segment of the worm wheel being removable to admit the axle. In order that the wheels may be held as rigidly as possible, the car wheel revolves on its own journals. Another advantage of this arrangement is that in grinding wheels with flat spots, in many instances the center holes in the axles may have been injured, or the journals may have been worn eccentric with the center holes. The journals rest on a half-bearing at either end, this bearing being composed of lumen bronze and its external surface forming one-half of a sphere, which rests in a pocket corresponding to it. This allows the bearing to adjust itself to a journal that may have been worn slightly tapering. A portion of the bearing is cut away at the bottom, allowing the journal to rest on a small segment of the circle of the bearing on two sides, thus accommodating any variation from standard size of the journal due to wear. The portion of the bearing which is cut away is filled with felt, which is kept saturated with oil, and the journal, pressing this felt as it



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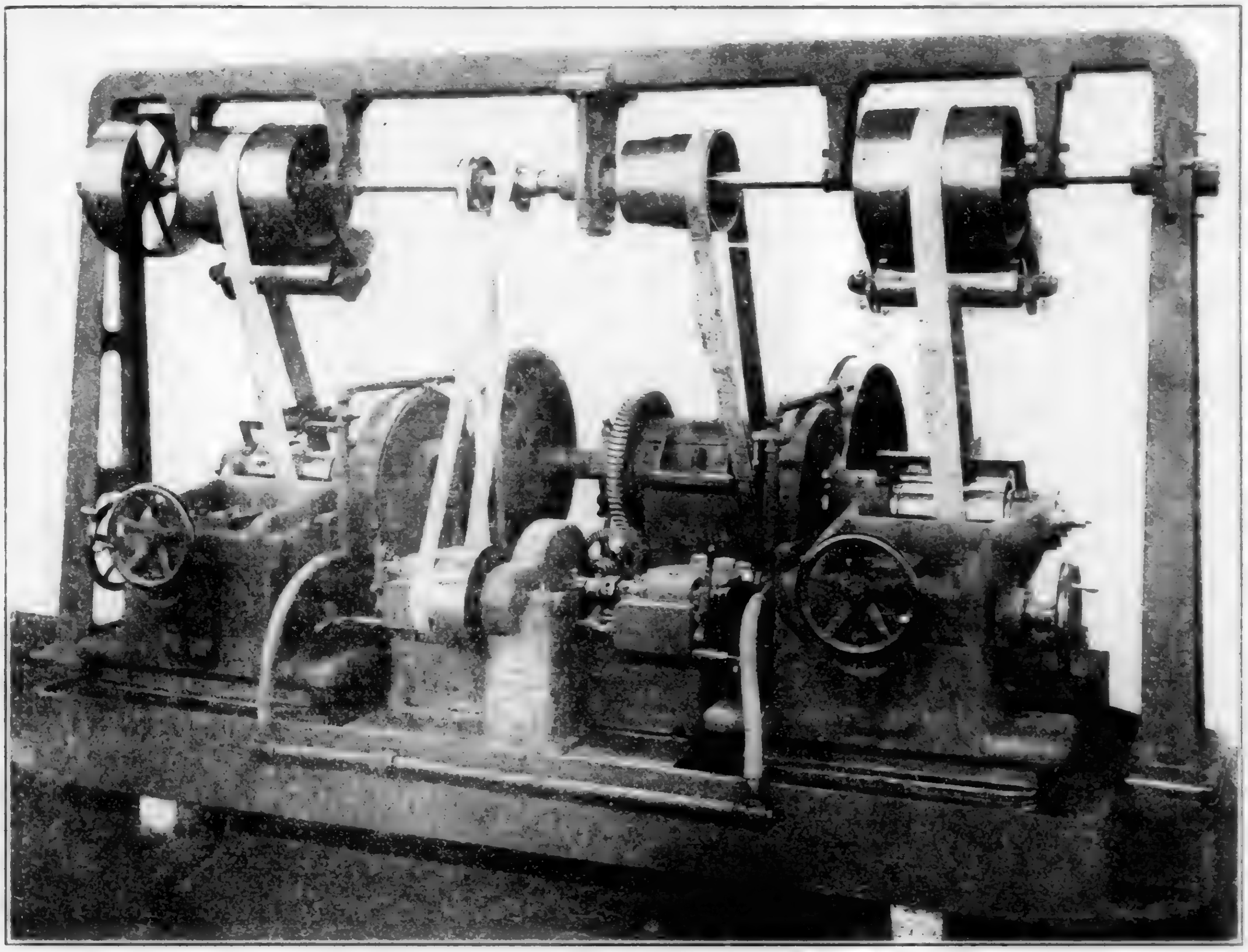
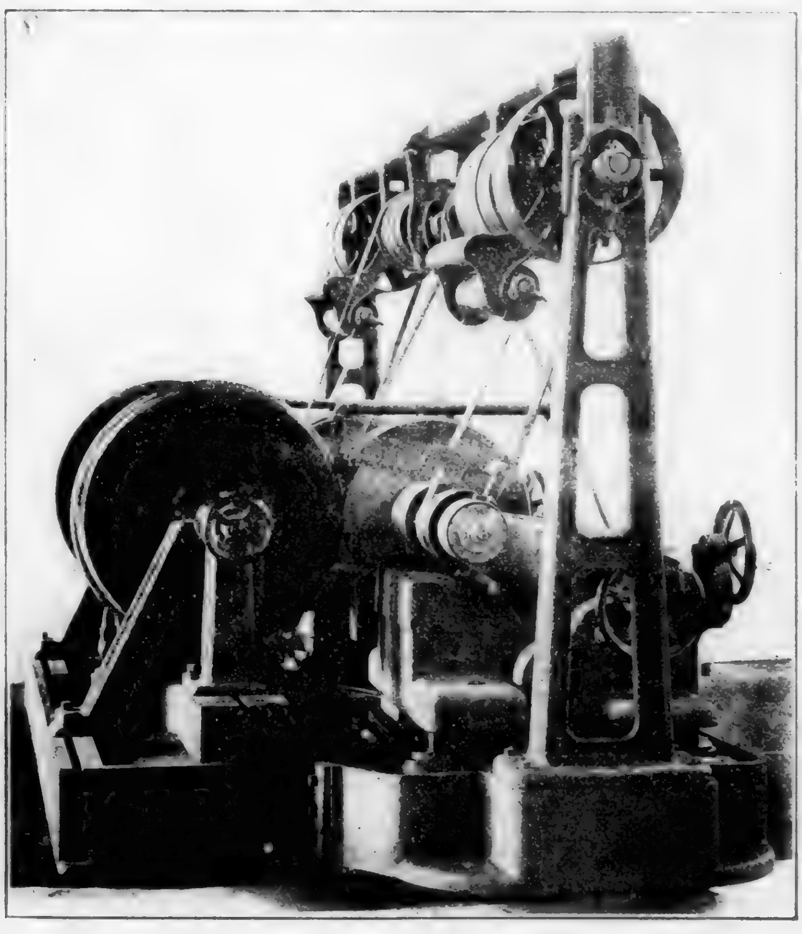


NORTON CAR WHEEL GRINDER—FRONT VIEW.



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revolves, is oiled automatically. The uprights which support the car axle are movable in line with the axle, thus making it possible to grind car wheels having the journals outside of the wheels as well as those having them on the inside.

The grinding wheels have 2¾-in. faces, are 24 ins. in diameter, and the weight of the wheel spindles and slides upon which they are mounted is 1,500 lbs. for each wheel. The slides upon which the grinding wheels are mounted are similar to the ones used on the regular Norton grinding machine. They are mounted on other slides that have a movement parallel with the face of the car wheel, and these are mounted on slide bases which rest upon the base of the machine. The slide base is pivoted, thus making it possible to arrange the traverse of the grinding wheel for a number of different angles of car-wheel faces. The slides operating parallel with the car-wheel face are immersed in oil, in order that there may be no possibility of them roughing up or sticking, due to the fact that they traverse very slowly and have only a comparatively short movement. When once filled with oil they will operate for a very long time without attention, probably for years. The slides traversing parallel with the face of the car wheel are arranged for automatic traverse, although, if necessary, the operator may move them for short distances by means of hand wheels. There is a clutch on either side of the driving gear, one of which is visible in the front view of the machine. The vertical handle shown at the right of this clutch is used for throwing it into engagement. The clutch, when engaged, is automatically locked, and operates a worm which drives a worm wheel mounted on a crank shaft, the shaft moving the slide a distance of 2 ins. Two small handles may be seen, one at the left and one at the right, the one at the right being partly obscured from view by the water hose. The raising of these handles will cause the slides to stop automatically when in the extreme position toward the flange of the car wheel. They are so arranged that the operator cannot stop the traverse of the slide at any other point of the stroke, thus preventing any misunderstanding on his part as to the relation of the grinding wheel and the car wheel flange when he is adjusting the hand wheels.

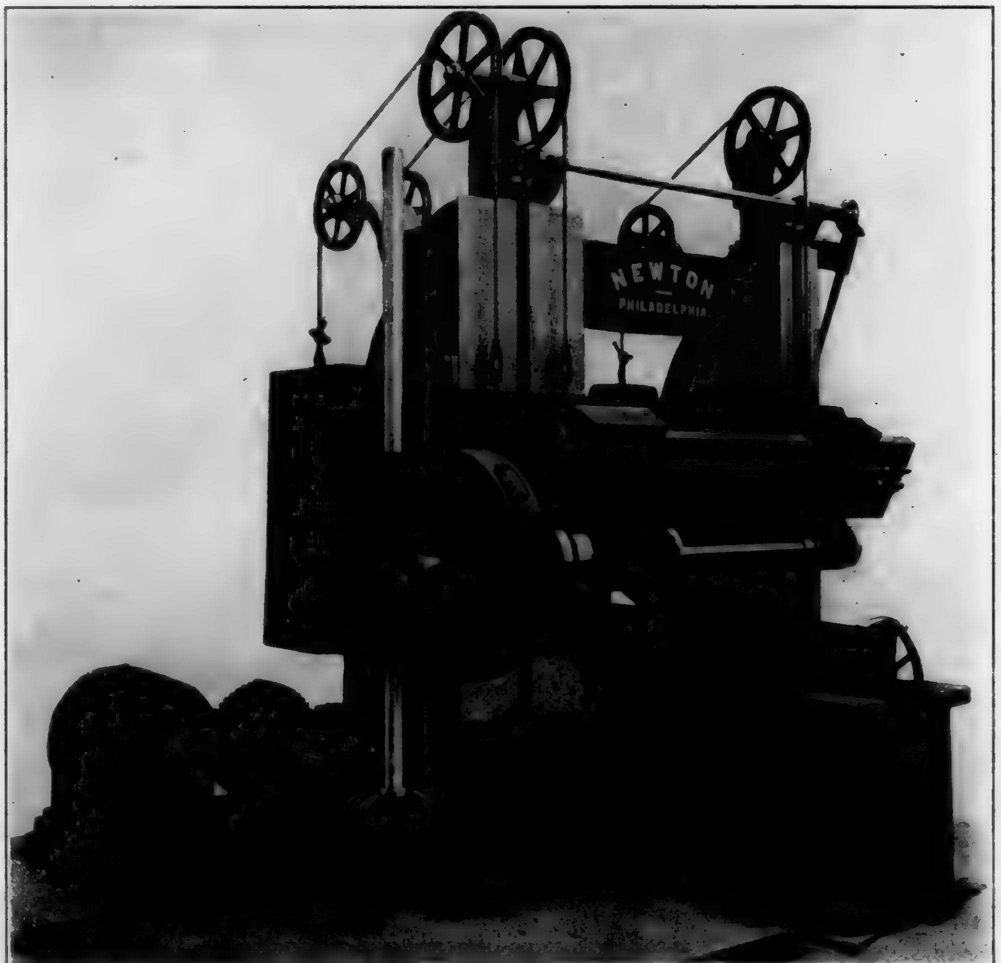
The mechanism for stopping the work revolution is so arranged that the operator can stop the worm and worm wheel at exactly the right position for putting in a car axle. The worms driving the worm wheels are immersed in oil and, as far as possible, all movable parts are covered with heavy guards. The screws for moving the slides, as well as the nuts in which they run, are massive, and every precaution has been taken to produce a machine that will stand very heavy rough usage and at the same time produce very accurate work. The machine weighs complete about 30,000 lbs.

It is arranged with self contained overhead works, permitting the passage of an overhead crane and the lifting of the car wheels and axles in and out of the machine. The machine may be driven either by a belt from a line shaft or by a 30 h.p. constant speed motor. It is provided with a water circulating apparatus having a capacity of 80 gals. per minute, 40 gals. on each wheel. The base of the machine is arranged with a settling tank and with a large water tank in the foundation, from which the machine draws its supply. The settling tank is arranged so that it may be removed by the overhead crane and emptied when necessary.

PLANER TYPE MILLING MACHINE.

The illustration shows an improved design of Newton horizontal slab milling machine of a size especially adapted to railroad shop work. The design and construction are such as to make this machine very rigid and enable it to work the milling cutters to their full capacity. One of these machines, in operation in a locomotive shop, recently removed 18 lbs. from a connecting rod in three minutes.

The table is 30 ins. wide and may be made to mill any desired length. The spindle is 6 ins. in diameter. The cross-



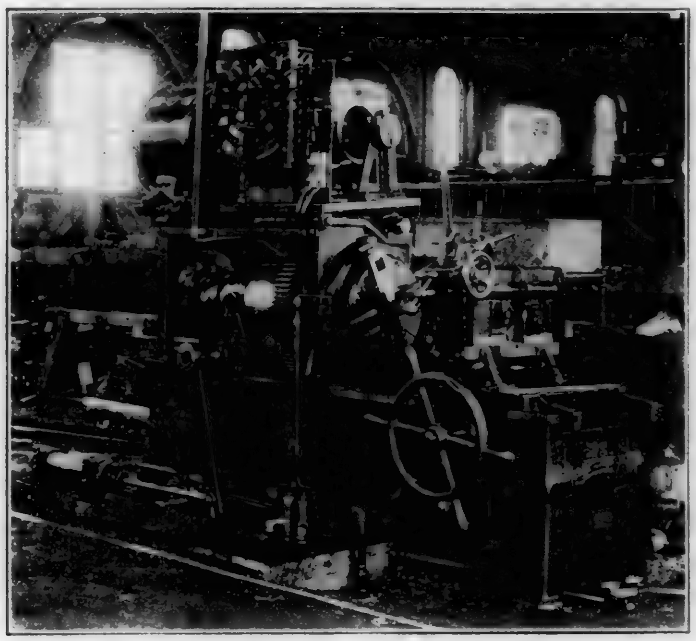
NEWTON PLANER TYPE MILLING MACHINE.

rail is of the angular face design, is counterweighted, and may be adjusted either by hand or by power. The spindle is operated by means of a worm and a worm wheel, the worm wheel being of phosphor bronze and the worm of case-hardened steel. The center of the spindle may be raised 32 ins. from the carriage and the uprights will admit work 36 ins. wide. The main upright has a 22-in. face. The carriage is operated by means of a spiral pinion and rack and has nine changes of feed through gearing, with a power quick traverse and hand adjustment. The motor is bolted to an extension of the base of the machine and is a General Electric variable speed 20-h.p. machine, having a speed variation of 2 to 1. The milling machine is made by the Newton Machine Tool Works, Philadelphia, Pa.

LETTER BALLOT.—The letter ballot of the Master Car Builders' Association resulted in the adoption of all the suggested changes in the standards and rules, except the change in text relating to hand-holds.

INTERESTING ATTACHMENT TO A PIPE MACHINE.

An interesting attachment for operating the gripping chuck of a Bignall & Keeler P. D. Q. C. No. 4 improved pipe threading and cutting machine was recently made and applied at the Burlington shops, Aurora, Ill. The pipe machine was specially designed for use where a number of pieces of pipe of the same size were to be cut and threaded at the same time.



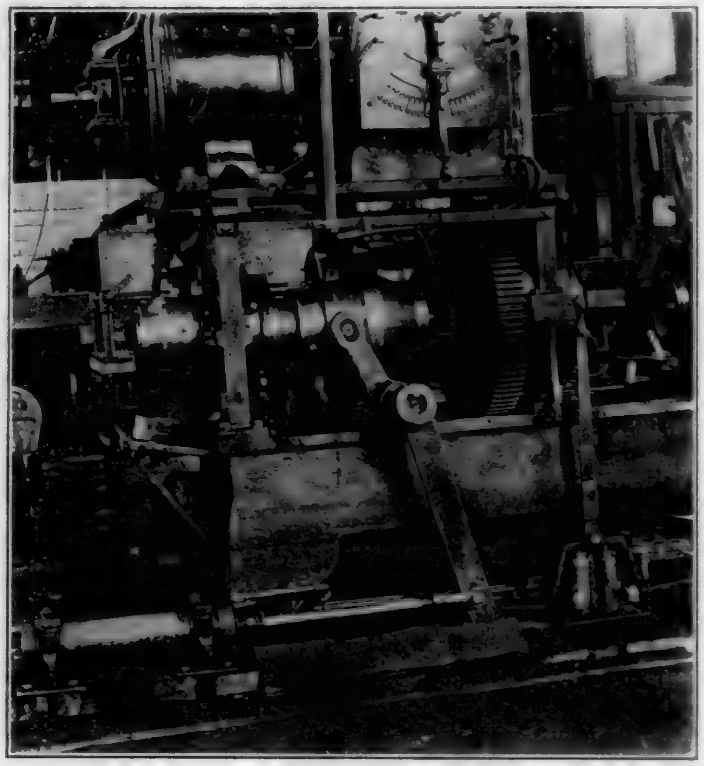
GENERAL VIEW OF PIPE MACHINE.

When the gripping chuck and dies are set for a given size the machine need not be stopped until all the pieces are cut and threaded.

The gripping chuck, as furnished by the builder, was operated by a hand lever, and in order to save time and exertion on the part of the operator a pneumatic device for operating the chuck was applied, as shown on the accompanying illustrations. The hand lever was replaced by the arm which projects downward and is connected to the piston rod. The air cylinder is of brass and was picked up out of the scrap pile; it is 4 ins. in diameter and has a 15-in. stroke. The ¾-in. four-way air valve is larger than necessary, and was designed for another purpose. By pressing down on the treadle air is allowed to enter the cylinder and throw in the clutch. By pushing the lever, which is very easily operated and is convenient to the operator, to the left, the clutch is released. The four-way cock has leather seats, which are perfectly tight, and the greater first cost is more than offset by the saving in air. Springs keep the valves shut against the air pressure, and are so graduated that only a very small pressure on the stem is necessary.

The machine will thread pipe from 1 to 4 ins., and is driven by a 3-h.p., 220-volt direct current Bullock constant speed motor. The motor drives a four-step cone through gearing. The short belt connecting the two cones is tightened by means of cams under the hinged motor table. Eight spindle speeds are available, and the spindle may be reversed by the Cutler-Hammer reversing box.

The machine is equipped with the Peerless die head, which requires but one movement of the lever to set the dies for cutting or to release them so that the pipe may be withdrawn. An automatic oil pump furnishes a continuous supply of oil for the dies and cutting-off tools.



PNEUMATIC ATTACHMENT ON PIPE MACHINE.

GOLDEN "CLEAN-SEAT" VALVES.

The Golden-Anderson Valve Specialty Company, Fulton Building, Pittsburgh, Pa., has recently brought out a new type of globe and angle valve, which contains a number of excellent features. These valves are made of a heavy pattern, particular attention being given to the diaphragm, making it very rigid so that it will form a square seat for the valve at all times. The special features in which this valve differs from others are found in the construction of the disc and in the joint between the bonnet and the body. The bottom of the disc is hollow, with solid cast eccentric lugs on the side. There is a slot or groove cut through between the lugs and also around the entire outside diameter, and, consequently, in closing the valve when the slot comes flush with the seat, the water, steam or air blows out through the groove across the seat on both the diaphragm and the disc and absolutely cleans them just before the seating of the valve. It will be noticed that there is a projection on the bottom of the valve which acts as the first cut-off or throttle and protects the seat and disc against the disastrous wire-drawing of the steam. This construction is especially important when the valve is cracked or slightly open as at that time the steam escapes through

revolves, is oiled automatically. The uprights which support the car axle are movable in line with the axle, thus making it possible to grind car wheels having the journals outside of the wheels as well as those having them on the inside.

The grinding wheels have $2\frac{3}{4}$-in. faces, are 24 ins. in diameter, and the weight of the wheel spindles and slides upon which they are mounted is 1,500 lbs. for each wheel. The slides upon which the grinding wheels are mounted are similar to the ones used on the regular Norton grinding machine. They are mounted on other slides that have a movement parallel with the face of the car wheel, and these are mounted on slide bases which rest upon the base of the machine. The slide base is pivoted, thus making it possible to arrange the traverse of the grinding wheel for a number of different angles of car-wheel faces. The slides operating parallel with the car-wheel face are immersed in oil, in order that there may be no possibility of them roughing up or sticking, due to the fact that they traverse very slowly and have only a comparatively short movement. When once filled with oil they will operate for a very long time without attention, probably for years. The slides traversing parallel with the face of the car wheel are arranged for automatic traverse, although, if necessary, the operator may move them for short distances by means of hand wheels. There is a clutch on either side of the driving gear, one of which is visible in the front view of the machine. The vertical handle shown at the right of this clutch is used for throwing it into engagement. The clutch, when engaged, is automatically locked, and operates a worm which drives a worm wheel mounted on a crank shaft, the shaft moving the slide a distance of 2 ins. Two small handles may be seen, one at the left and one at the right, the one at the right being partly obscured from view by the water hose. The raising of these handles will cause the slides to stop automatically when in the extreme position toward the flange of the car wheel. They are so arranged that the operator cannot stop the traverse of the slide at any other point of the stroke, thus preventing any misunderstanding on his part as to the relation of the grinding wheel and the car wheel flange when he is adjusting the hand wheels.

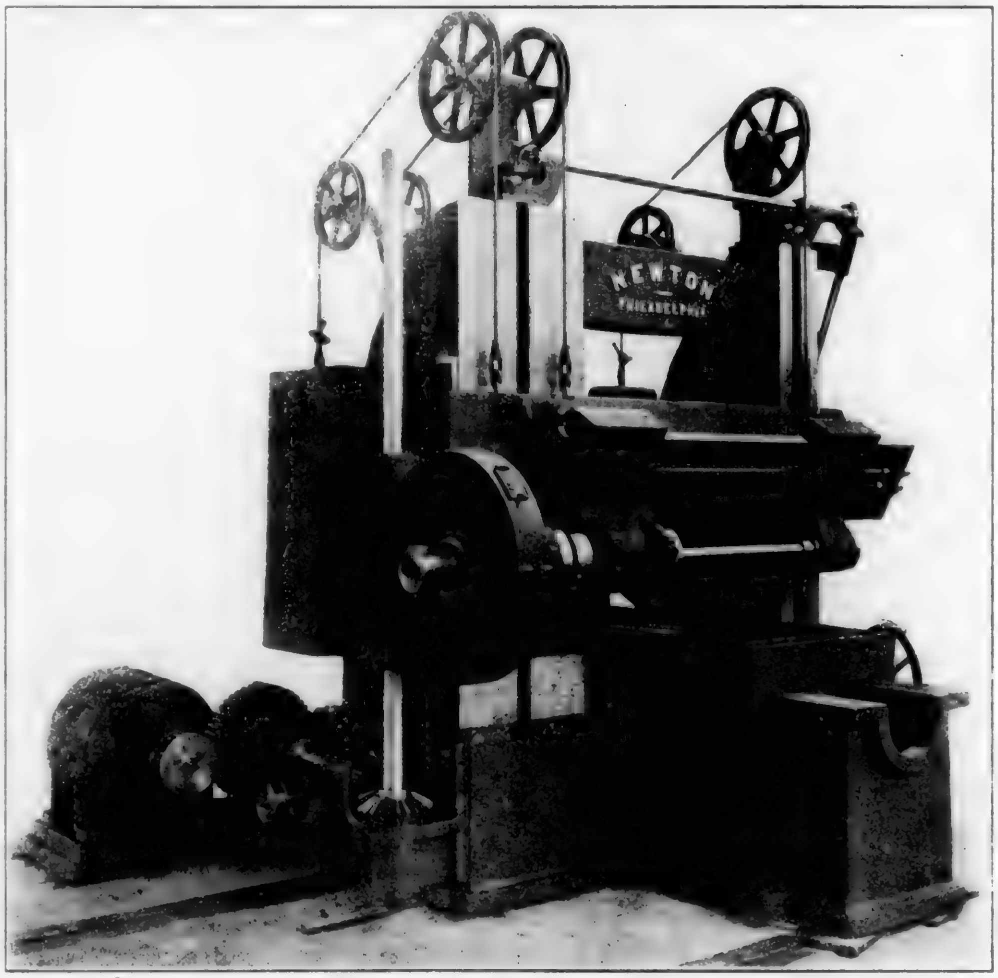
The mechanism for stopping the work revolution is so arranged that the operator can stop the worm and worm wheel at exactly the right position for putting in a car axle. The worms driving the worm wheels are immersed in oil and, as far as possible, all movable parts are covered with heavy guards. The screws for moving the slides, as well as the nuts in which they run, are massive, and every precaution has been taken to produce a machine that will stand very heavy rough usage and at the same time produce very accurate work. The machine weighs complete about 30,000 lbs.

It is arranged with self contained overhead works, permitting the passage of an overhead crane and the lifting of the car wheels and axles in and out of the machine. The machine may be driven either by a belt from a line shaft or by a 30 h.p. constant speed motor. It is provided with a water circulating apparatus having a capacity of 80 gals. per minute, 10 gals. on each wheel. The base of the machine is arranged with a settling tank and with a large water tank in the foundation, from which the machine draws its supply. The settling tank is arranged so that it may be removed by the overhead crane and emptied when necessary.

PLANER TYPE MILLING MACHINE.

The illustration shows an improved design of Newton horizontal slab milling machine of a size especially adapted to railroad shop work. The design and construction are such as to make this machine very rigid and enable it to work the milling cutters to their full capacity. One of these machines, in operation in a locomotive shop, recently removed 18 lbs. from a connecting rod in three minutes.

The table is 30 ins. wide and may be made to mill any desired length. The spindle is 6 ins. in diameter. The cross-rail is of the angular face design, is counterweighted, and may be adjusted either by hand or by power. The spindle is operated by means of a worm and a worm wheel, the worm wheel being of phosphor bronze and the worm of case-hardened steel. The center of the spindle may be raised 32 ins. from the carriage and the uprights will admit work 36 ins. wide. The main upright has a 22-in. face. The carriage is operated by means of a spiral pinion and rack and has nine changes of feed through gearing, with a power quick traverse and hand adjustment. The motor is bolted to an extension of the base of the machine and is a General Electric variable speed 20-h.p. machine, having a speed variation of 2 to 1. The milling machine is made by the Newton Machine Tool Works, Philadelphia, Pa.

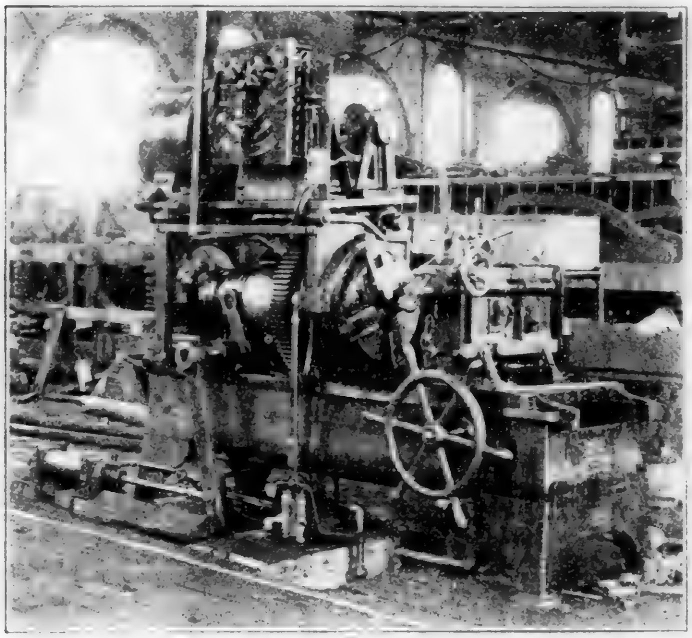


NEWTON PLANER TYPE MILLING MACHINE.

LETTER BALLOT.—The letter ballot of the Master Car Builders' Association resulted in the adoption of all the suggested changes in the standards and rules, except the change in text relating to hand-holds.

INTERESTING ATTACHMENT TO A PIPE MACHINE.

An interesting attachment for operating the gripping chuck of a Bignall & Keeler P. D. Q. C. No. 4 improved pipe threading and cutting machine was recently made and applied at the Burlington shops, Aurora, Ill. The pipe machine was specially designed for use where a number of pieces of pipe of the same size were to be cut and threaded at the same time.



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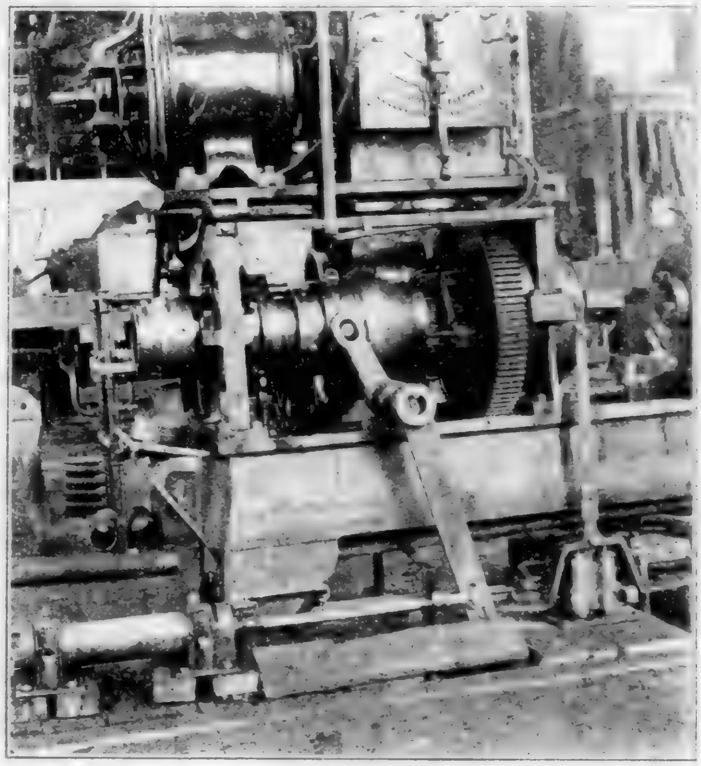
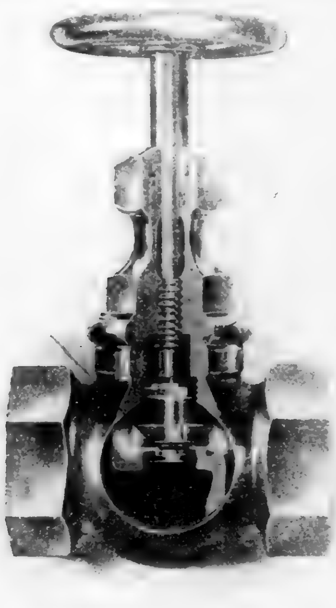


PNEUMATIC ATTACHMENT ON PIPE MACHINE.

GOLDEN "CLEAN-SEAT" VALVES.



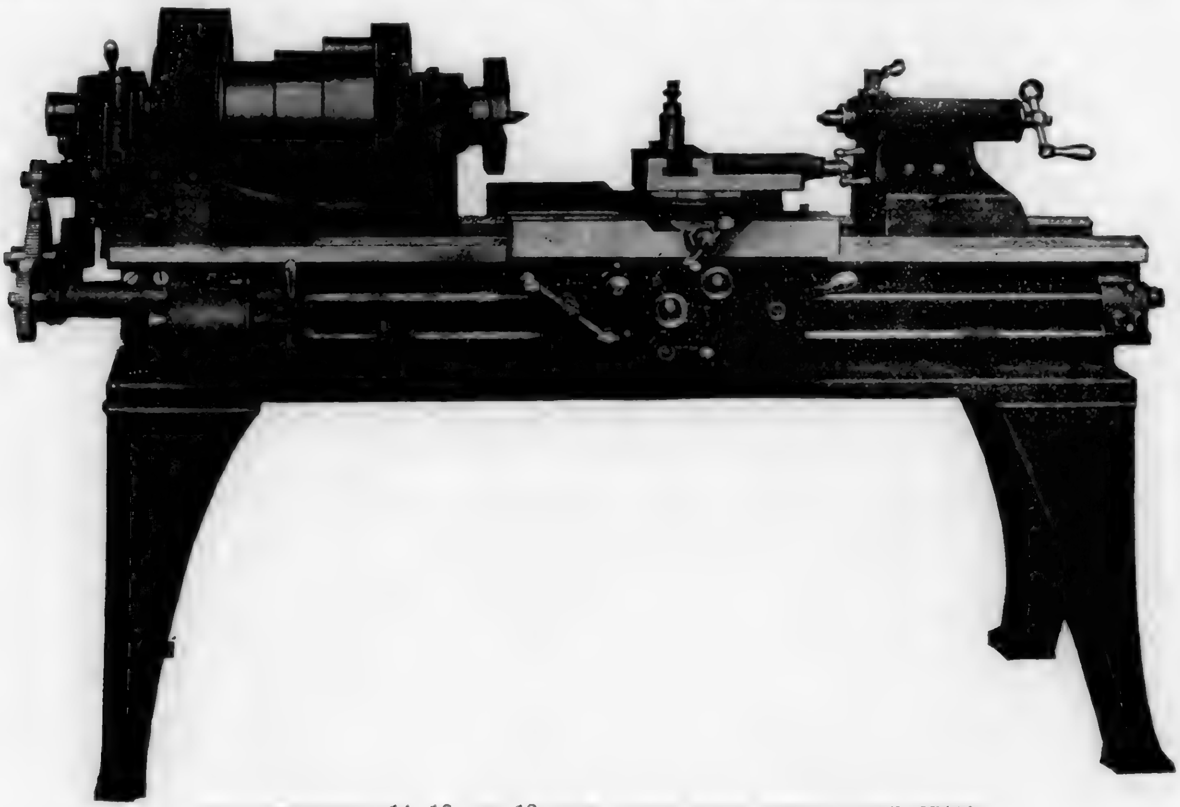
The Golden-Anderson Valve Specialty Company, Fulton Building, Pittsburgh, Pa., has recently brought out a new type of globe and angle valve, which contains a number of excellent features. These valves are made of a heavy pattern, particular attention being given to the diaphragm, making it very rigid so that it will form a square seat for the valve at all times. The special features in which this valve differs from others are found in the construction of the disc and in the joint between the bonnet and the body. The bottom of the disc is hollow, with solid cast eccentric lugs on the side. There is a slot or groove cut through between the lugs and also around the entire outside diameter, and, consequently, in closing the valve when the slot comes flush with the seat, the water, steam or air blows out through the groove across the seat on both the diaphragm and the disc and absolutely cleans them just before the seating of the valve. It will be noticed that there is a projection on the bottom of the valve which acts as the first cut-off or throttle and protects the seat and disc against the disastrous wire-drawing of the steam. This construction is especially important when the valve is cracked or slightly open as at that time the steam escapes through

the hollow disc and the groove without any injury to the seat. The valve is so constructed that it can be packed when open since the back of the valve disc is flat and comes to a seat on the bottom of the bonnet. The valve seat is flat and narrow. It will be noticed that the joint between the bonnet and body is made with a bevel joint and that the threaded part is extra long, thus forming an absolutely tight connection at this point. These valves are made in different sizes for steam pressures up to 600 lbs. and for hydraulic or air pressure up to 2,500 lbs. They are made with both screwed and flanged ends up to 3 ins. in diameter.

The same company also make a boiler blow-off valve which contains the same special features. In that case, however, the body of the valve being of iron or steel is fitted with renewable bronze seats and bronze discs.

and a tank and pump. The net weight of the 18-in. lathe with a 6-ft. bed, taking 2 ft. between centers, is 2,600 lbs., while the corresponding weights for the 16 and 14-in. lathes are 2,100 and 1,600 lbs., respectively.

Master Blacksmiths' Association.—The following officers have been elected by the International Railroad Master Blacksmiths' Association: President, John S. Sullivan, P. R. R., Columbus, Ohio; first vice-president, George H. Judy, B. & O., Pittsburgh; second vice-president, J. W. Russell, P. R. R., Renova, Pa.; secretary-treasurer, A. L. Woodworth, C., H. & D., Lima, Ohio; chemist, George H. Williams, B. M. Jones & Company, Medford, Mass. The 1907 convention will be held in Montreal, Canada.



NEW SPRINGFIELD 14, 16 AND 18 INCH LATHE WITH DOUBLE BACK GEARS.

NEW SPRINGFIELD ENGINE LATHE.

A new line of standard engine lathes, 14, 16 and 18 ins., equipped with three-step cones and double back gears, thus furnishing eighteen different spindle speeds in connection with a two-speed countershaft, and making it possible to use exceptionally wide belts for lathes of these sizes, has recently been placed on the market by The Springfield Machine Tool Company, Springfield, Ohio. The back gear ratios are 3 to 1 and 9½ to 1, and this, with a 3¼-in. belt on the 16-in. lathe and a 3¾-in. belt on the 18-in., furnishes sufficient power to take care of the heaviest work within the range of these machines. The wide range of spindle speeds, a convenient feed arrangement and the powerful drive make it possible to turn out quickly and accurately either light or heavy work.

The spindles are of large diameter, and are equipped with ring oil bearings, which may be replaced with new ones in case of accidental damage and still maintain the original alignment of the spindle. The spindles have large holes (1 9-16 ins. on the 18-in lathe) throughout their entire length, making it possible to operate on long bars.

The feeds are geared and so arranged that any one of the six changes, from the coarsest to the finest, may be obtained instantly. If the range of feeds within the feed box is not great enough a change of gears on the lead screw will furnish an additional six feeds. If desired, the lathes may be furnished with the Ideal rapid change gear device, an oil pan

Master Mechanics' Letter Ballot.—As a result of the letter ballot of the Master Mechanics' Association the specifications for foundry pig iron, the specifications for cylinder castings, etc., and the fittings for lubrication were adopted as standard.

PERSONALS.

Mr. Daniel P. Tait, foreman of the Steubenville, Ohio, shops of the Pennsylvania Lines West, is dead.

Mr. T. Harris has been appointed divisional car foreman of the Canadian Pacific Railway at North Bay, Ont.

Mr. A. L. Graburn, superintendent of shops of the Great Northern Railway at St. Cloud, Minn., has resigned.

Mr. H. C. Gribben has resigned as general foreman of shops of the Alabama Great Southern Railroad at Birmingham, Ala.

Mr. C. S. Mills has been appointed master mechanic of the Buffalo & Susquehanna Railway, with headquarters at Galeton, Pa.

Mr. C. R. Williams, general master mechanic of the Buffalo & Susquehanna Railway, has resigned, and the position is abolished.

Mr. W. D. Cox has been appointed general foreman of the Lake Shore & Michigan Southern Railway at Air Line Junction, Ohio.

Mr. R. Breese, machine shop foreman of the Pennsylvania Lines West, at Fort Wayne, has been appointed assistant master mechanic.

Mr. George Thomson has been appointed assistant general foreman of the Lake Shore & Michigan Southern Railway at Collinwood, Ohio.

Mr. T. F. Dreyfus has been appointed superintendent of motive power of the Buffalo & Susquehanna Railway, with headquarters at Galeton, Pa.

Mr. Charles T. Bayless, for the last five years mechanical engineer of the Mexican Central Railroad, died at his home in Aguascalientes, Mexico.

Mr. E. F. Flory has been appointed general foreman of shops of the Lehigh & New England Railroad at Pen Argyl in place of Mr. H. L. Wren, resigned.

Mr. C. B. Smith, heretofore division master mechanic of the Boston & Maine Railroad, has been promoted to mechanical engineer, with office at Boston, Mass.

Mr. R. L. Wyman has been appointed master mechanic of the Lehigh & New England Railroad, with office at Pen Argyl, Pa., vice Mr. F. S. Anthony, resigned.

Mr. A. H. Gairns has been appointed master mechanic of the Denver & Rio Grande Railroad, with office at Grand Junction, Colo., vice J. W. Hardy, resigned.

Mr. E. E. Turney, formerly with the Pere Marquette, has been appointed master car builder of the Cincinnati, Hamilton & Dayton Railway shops at Lima, Ohio.

Mr. Walter Johnson, assistant engine-house foreman of the Pennsylvania Lines West, at Fort Wayne, has been appointed machine shop foreman in place of Mr. Breese.

Mr. W. G. Edgar has been appointed master mechanic of the St. Louis, Iron Mountain & Southern Railway at Helena, Ark., in place of Mr. J. A. Greenoe, resigned.

Mr. J. F. Leak has been appointed master car builder for the Southern Railway at Knoxville, succeeding Mr. J. W. Armstrong, transferred to the shops at Memphis.

Mr. H. E. Culbertson has been appointed master mechanic of the McCook Division of the Chicago, Burlington & Quincy Railway at McCook, Neb., in place of Mr. Kennedy.

Mr. Cassius Brady, formerly engineer of tests of the Great Northern Railway, has been appointed mechanical engineer of the Texas & Pacific Railway, at Marshall, Texas.

Mr. G. C. Johnson has been appointed master mechanic of the Lincoln Division of the Chicago, Burlington & Quincy Railway, with office at Lincoln, in place of Mr. Dietrich.

Mr. Henry Carrick, district foreman of the Oregon Short Line at Montpelier, Idaho, has been appointed division master mechanic at Pocatello, Idaho, succeeding Mr. W. J. Tollerton, resigned.

Mr. J. C. Little, chief draftsman of the Louisville & Nashville R. R. at Louisville, has been appointed mechanical engineer of the Chicago & Northwestern Railroad at Chicago, Ill.

Mr. F. C. Lindt, general foreman of shops of the Great Northern Railway at McCloud, Minn., has been appointed superintendent of shops at that place, succeeding Mr. A. L. Graburn, resigned.

Mr. F. Cochran has been appointed general foreman of the car department of the Lake Erie & Western Railroad at Toledo, Ohio, in place of Mr. George W. Deibert, who has been transferred to Peru, Ind.

Mr. D. J. Durrell, assistant engineer of motive power of the Pennsylvania Lines West at Columbus, has been transferred to Cincinnati, succeeding Mr. P. T. Dunn as general foreman of locomotive and car repairs.

Mr. J. W. Evans has been appointed master mechanic of the Alabama Great Southern Railroad at Birmingham, Ala., succeeding Mr. W. H. Dooley, who has been appointed superintendent of the Ferguson shops.

Mr. F. E. Kennedy, master mechanic of the Chicago, Burlington & Quincy Railway at McCook, Neb., has been transferred to Sheridan, Wyo., as master mechanic of the Sheridan Division, succeeding Mr. Johnson.

Mr. Dennison Gallaudet, general foreman of the Glenwood shops of the Baltimore & Ohio Railroad, has been appointed master mechanic of the Chicago Division at Garrett, Ind., to succeed Mr. J. E. Davis, resigned.

Mr. A. S. McFarland, general foreman of the Southern Indiana at Terre Haute, Ind., has been appointed general foreman of the Missouri Pacific Railway at Wichita, Kan., vice Mr. Frank M. Spangler, resigned.

Mr. W. J. Haskin, heretofore general master mechanic of the Chicago & Eastern Illinois Railroad, has been appointed assistant superintendent of machinery of the Missouri Pacific Railway, with headquarters at St. Louis, Mo.

Mr. T. O. Sechrist, general foreman of the Cincinnati, New Orleans & Texas Pacific at Somerset, Ky., has been appointed master mechanic of the Alabama Great Southern Railroad at Chattanooga, Tenn., succeeding Mr. Evans.

Mr. J. Dietrich, heretofore master mechanic of the Chicago, Burlington & Quincy Railway at Lincoln, Neb., has been appointed assistant superintendent of the lines west of the Missouri River, with headquarters at Lincoln.

Mr. W. Moir, general master mechanic of the Northern Pacific Railway, with office at Tacoma, Wash., has been appointed acting mechanical superintendent, with headquarters at St. Paul, Minn., succeeding Mr. D. Van Alstyne, resigned.

Mr. David Anderson, formerly general foreman of the locomotive and car department of the Indiana Harbor Railroad at Indiana Harbor, Ind., has been appointed general foreman of the Harvey Foundry & Machine Company at Harvey, Ill.

Mr. C. D. Young, assistant master mechanic, Pennsylvania Lines, Northwest system, at Fort Wayne, Ind., has been appointed assistant engineer of motive power, Southwest system, with office at Columbus, Ohio, to succeed Mr. Durrell.

Mr. T. H. Goodnow has been appointed master car builder of the Michigan Southern Division of the Lake Shore & Michigan Southern Railway, excluding Toledo and Air Line Junction, with office at Englewood, Ill., to succeed Mr. Downing.

Mr. L. F. Johnson, assistant master mechanic of the Pennsylvania Lines at Allegheny, Pa., has been appointed general foreman of the motive power department of the Toledo Division at Toledo, Ohio, in place of Mr. T. F. Dreyfus.

Mr. P. T. Dunn, general foreman of locomotive and car repairs of the Pennsylvania Lines West at Cincinnati, Ohio, has been appointed master mechanic of the Chicago terminal division, with office at Chicago, to succeed Mr. N. M. Loney, resigned.

Mr. M. J. McGaw, master mechanic of the Missouri Pacific Railway at Fort Scott, Kan., has been transferred to St. Louis, Mo., in a similar capacity, succeeding Mr. L. Bartlett, retired. Mr. M. C. Walsh has been appointed to succeed Mr. McGaw at Fort Scott.

Mr. W. C. A. Henry, heretofore assistant superintendent of motive power of the Southwest system of the Pennsylvania Lines, has been appointed superintendent of motive power of that system, with headquarters at Columbus, Ohio, succeeding M. Dunn, deceased.

Mr. W. J. Schlacks, superintendent of machinery of the Colorado Midland Railroad, has resigned to take the management of the central department of a Chicago wholesale manufacturer of railroad supplies, with headquarters in Chicago.

Mr. W. R. Wilson has been appointed to succeed Mr. Thomson as division general foreman of the Michigan Southern Division of the Lake Shore & Michigan Southern Railway, with jurisdiction over LaPorte and all points east on main line and branches, with headquarters at Elkhart, Ind.

Mr. George Thomson, heretofore division general foreman of the Lake Shore & Michigan Southern Railway at Elkhart, Ind., has been appointed division general foreman of that road, the Lake Erie, Alliance & Wheeling and the Dunkirk, Allegheny Valley & Pittsburgh, with office at Collinwood, Ohio, vice Mr. John McCabe, transferred.

Mr. Ira S. Downing has been appointed master car builder of the Lake Shore Division of the Lake Shore & Michigan Southern Railway, including Toledo and Air Line Junction, and of the Lake Erie, Alliance & Wheeling and Dunkirk, Allegheny Valley & Pittsburgh roads, with headquarters at Collinwood, Ohio, vice Mr. Joseph Chidley, who will devote his entire time to locomotive department work.

Mr. Tracy Lyon has resigned as assistant general manager of the Chicago & Great Western Railway to accept a position with the Westinghouse Electric & Mfg. Company. Mr. Lyons was born in Oswego, N. Y., in 1865, and is a graduate of the Massachusetts Institute of Technology. Upon graduation he was a member of the firm of Robert Bement & Company, engineers and contractors of St. Paul. He remained with them until 1894, at which time he was appointed master mechanic of the Chicago Great Western Railway, where he remained for five years. From July, 1899, to March, 1902, he was general superintendent of the same road, and from the latter date until the present time has been assistant general manager. Mr. Lyon is a member of the American Society of Mechanical Engineers.

Mr. David VanAlstyne has resigned as mechanical superintendent of the Northern Pacific Railway to go with the American Locomotive Company. Mr. VanAlstyne was born on June 14, 1865, at Louisville, Ky., and was educated at the Massachusetts Institute of Technology, graduating in 1886. He entered railroad service in that year as machinist apprentice on the Louisville & Nashville Railroad, remaining with that road for eight years, rising to roundhouse foreman. He then spent three and a half years in the foundry business; one year as master mechanic of the Louisville, Henderson & St. Louis Railway; six months as master mechanic of the Great Western Railway, rising to superintendent of motive power of the same road, where he remained from 1899 to May, 1904, at which time he was appointed mechanical superintenedent of the Northern Pacific Railway, which position he held up to the present time.

BOOKS.

Wiring a House. By Herbert Pratt. Published by The Derry-Collard Company, 109 Liberty Street, New York. 19 pages, 6 illustrations. Price, $.25.

This is No. 6 of a series of practical papers. It explains carefully and simply the various steps in the wiring of a modern home.

Brazing and Soldering. By James F. Hobart. Published by The Derry-Collard Company, 109 Liberty Street, New York. 33 pages, 16 illustrations. Price, $.25.

This is No. 5 of a series of practical papers, published by the above company. It gives complete instructions for all kinds of hard and soft soldering; shows what tools to use, how to make them and how to use them.

American Steel Worker. Second Edition. By E. R. Markham. 366 pages, 163 illustrations. Cloth. Published by the Derry-Collard Company, N. Y. Price, $2.50.

This is the second edition of this well-known and excellent book, and has been carefully revised and enlarged by the author. A chapter on high speed steel, which gives the latest information on this important subject, has been added. The book considers the handling and use of tool steels in the most careful manner, and since it is written by a practical man, who has had an experience in this line covering more than 25 years, it is full of most valuable information for the tool users as well as the toolmakers. In view of the present vital importance of maintaining the tools on a par with the modern machines this book will be found to be a valuable aid for all toolmakers and users.

Cincinnati, Hamilton & Dayton Railway Shops at Ivorydale, Ohio. A pamphlet published by The Arnold Company, 181 La Salle Street, Chicago, Ill.

These shops are near Cincinnati and provide facilities for taking care of locomotives lying over at Cincinnati between trips and for making light running repairs to the locomotives and cars operating on the division. The engine house, 254 by 90 ft., of the rectangular type, is served by a transfer table, and contains fourteen tracks on 18-ft. centers. The building is of reinforced concrete and hollow partition tile, the Kahn system being used for beams and roof slabs. On the opposite side of the transfer table is the erecting and boiler shop, 201 ft. by 123 ft. of steel and brick construction. The smith shop and power plant are included in an extension to this shop. The oil house is of reinforced concrete construction.

The other buildings are of brick and wood construction. The pamphlet presents a very complete description of the various buildings and their equipment, the plans and specifications for which, with the exception of the coaling station, installed by Fairbanks, Morse & Company, of Chicago, were prepared by The Arnold Company. The work was also done under their general supervision. A considerable portion of the pamphlet is devoted to an interesting description of the manner in which a piece of work of the kind is handled by The Arnold Company.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

McCord Draft Gear.—McCord & Company, Chicago, is issuing a catalog which illustrates and describes very completely the new design of draft gear recently perfected by them, which was illustrated in the American Engineer and Railroad Journal, July, 1906, page 274.

Reflection of a Rambler.—This is the title of a booklet being sent out by the Warner & Swasey Company, Cleveland, and contains a very pleasing little story which illustrates the pleasure and profit that can be obtained through the possession and use of a prism binocular. This instrument is very powerful and is manufactured in exceedingly small, compact designs.

Rock Drills.—The Ingersoll-Rand Company, 11 Broadway, New York City, is issuing an attractive catalog, containing many illustrations showing the details of construction and methods of operation of different types of rock drills manufactured by it. These drills contain the latest developments and refinements, and many new features both in construction and arrangement are shown.

Valve Specialties.—The Golden-Anderson Valve Specialty Company, Pittsburg, Pa., is issuing a leaflet which illustrates and describes several types of special valves for railroad use, some of which

are of the new "clean seat" type which design will keep both the disc and the valve seat perfectly clean; a balanced plug valve with a roller lock, a cushion non-return valve, which will equalize between different units of battery of boilers and a tilting steam trap, etc.

THE OIL PROBLEM.—S. F. Bowser and Company, Fort Wayne, Ind., is issuing a leaflet which describes the many advantages of their system of handling oils and illustrates a well designed and equipped oil house on one of the large railroad systems. This company furnishes the tanks, self-measuring pumps and all other apparatus needed to equip a modern railroad oil house.

COMMERCIAL LIGHTING OF INDUSTRIAL PLANTS.—The Cooper-Hewitt Lamp Company, Pittsburg, Pa., is issuing a nicely illustrated pamphlet which gives some very valuable suggestions in connection with the efficient and satisfactory lighting of industrial plants, both as to offices and shops. The subject is of sufficient importance to deserve careful attention, and the pamphlet contains some very useful suggestions.

ELECTRICAL EQUIPMENT.—The General Electric Company, Schenectady, N. Y., is issuing a large number of new bulletins and flyers arranged for binding in their loose leaf binder, several of which will be of interest to motive power men. These include instructive and interesting matter on single phase motors, railway motors, generators, arc and incandescent lamps, switches, multiple unit control, etc. Indexes to the previous issues can also be obtained.

CAR AND TRUCK ORDER GUIDE.—The J. G. Brill Company, Philadelphia, is issuing a large order guide which shows illustrations of its different designs of car trucks, brake rigging and special body features, with each part numbered and accompanied by a list giving the proper name for that part. This order guide will be found to be of value not only in ordering the special parts, but also as reference for the proper names of parts of street car bodies and trucks.

CAST IRON PULLEYS.—The George V. Cresson Company, Philadelphia, is issuing a very complete catalog of cast iron pulleys in all shapes and sizes. Each design is illustrated and accompanied by a table of prices and sizes. Several other specialties are also included in the catalog, including oiling arrangements for pulleys; a patent loose pulley arrangement, which offers several features of advantage; a pneumatic pulley, which will increase the power transmitted by the belt, etc.

PUNCHING AND SHEARING MACHINES.—The Cincinnati Punch & Shear Company, Cincinnati, Ohio, has issued Catalog No. 10, describing their line of punching and shearing machines, bending and straightening rolls and plate doublers. These may be arranged for belt, motor or engine drive. The punching and shearing machines are equipped with the patent positive, adjustable, automatic stop and sliding clutch on angular shaft, which were described on page 65 of our February, 1905, issue.

RAILROAD HYDRAULIC TOOLS.—The Watson-Stillman Company, New York, is issuing catalog No. 69, which shows a very complete line of hydraulic tools for railroad use, including jacks in many different designs and sizes, both plain and telescopic; hydraulic screw punches, both portable and stationary; rail benders, crank pin presses in portable designs, both hand and motor driven wheel presses, portable bushing and shaft straightening presses, as well as specialties in connection with hydraulic tools. New features are noticed in many of these tools.

WATER TANKS AND SUBSTRUCTURES.—The Flint & Walling Manufacturing Company, Kendallville, Ind., is issuing Catalog No. 47, which describes and illustrates the details of the water tanks and superstructures manufactured by them. The illustrations and line drawings show a large number of recent installations furnished by this company, covering many different sizes of tanks arranged for various heads of pressure. As an example, one shows a tank of 100,000 gal. capacity on a superstructure 85 ft. high. Illustrations showing the details used in these tanks are also given. This subject is of particular interest because of the advantages it offers in reducing the cost of insurance.

RADIAL DRILLS.—The 1906 radial drill catalog from The Bickford Drill & Tool Company, Cincinnati, Ohio, has been received. It describes and illustrates the different lines of radial drills manufactured by them, including the 2½, 3 and 3½-ft. radials, fitted with gear drive and box, swinging or swiveling and round tables; their standard radial drills, Nos. 1, 2 and 3; their improved radial drills, Nos. 1, 2 and 3; plain and back-geared semi-radial drills, plain and adjustable wall radials and radials with round, fan-shaped, double-end and double column bases. A number of different arrangements for attaching motors are shown, also the Norris high speed attachment and a special tapping hood.

FEED WATER HEATERS.—Warren Webster & Company, Camden, N. J., is issuing Appendix No. 6 to Part L of their general catalog, which carefully explains the principle and operation of the Webster feed water heater, purifier, filter and receiver, which is entitled the "Star Vacuum." The catalog is illustrated in a manner which clearly explains the construction of the different parts. The same company is also issuing a pamphlet containing a paper on "Some Phases of the Feed Water Heater Problem," by Walter E. Harrington, which is reprinted from the Street Railway Journal of July 22, 1905. This paper carefully explains the requirements of a successful feed water heater, its advantages and discusses a number of the special features.

BULL DOG OF DRAFT GEARS.—The Farlow Draft Gear Company, Baltimore, Md., is issuing a pamphlet showing some most interesting illustrations of a completely wrecked coal car having steel center sills, which was equipped with Farlow draft gear. This car was so badly wrecked that the center sills were bent double upon themselves and the body was entirely destroyed. The coupler shank was badly bent, but the draft gear was not injured in the least. All parts, except the spring, which had a ⅛-in. set, were ready for use immediately. The illustrations are most interesting and instructive, and show the gear underwent the most severe test imaginable. This book will be of interest to all motive power men.

FIREPROOF PAINT.—The Joseph Dixon Crucible Company, Jersey City, is issuing a pamphlet entitled "Through 'Frisco's Furnace," which contains a number of excellent illustrations showing the different buildings in the city after the earthquake and fire of April 18, 1906. These are for the purpose of illustrating the protective qualities of Dixon's Silica-Graphite Paint when applied to steel work. They are accompanied by letters from achitects, who have examined the ruins and testify very strongly to the good protection afforded the steel work of many of the buildings by this paint. The same company is also issuing a small booklet descriptive of Dixon's Graphite Brushes for use on electric motors and dynamos. These brushes show to particular advantage in connection with high voltage, are self-lubricating and are the least harmful to the commutator.

PORTABLE TOOLS, ETC.—The Quincy, Manchester, Sargent Company, Old Colony Building, Chicago, Ill., is issuing a loose leaf binder, containing a number of articles descriptive of the line of material now being handled by that company. It is so arranged as to allow of the insertion of new or extra sheets, as changes are made in the design of the machine or new sizes and arrangements added. An index is included which will be corrected as occasion demands. The machines shown include metal sawing machines in many different sizes and arrangements, portable rail saws, portable cylinder boring bar, valve seat planing machine, portable crank pin turning machine, planer chucks, radius planer attachment, flue welder and cleaner, car wheel grinding machine, multiple drills, pneumatic cranes and hoists, both jib and trolley, riveting machinery of all kinds, elastic nuts, car and engine replacers, Ajax diaphragm, Priest snow flanger, brake shoe keys, Globe ventilators, rail benders and Stanwood steps.

ATLANTIC TYPE PASSENGER LOCOMOTIVES.—The American Locomotive Company has issued a new catalog on the subject of Atlantic Type Passenger Locomotives, being the second of a series of catalog pamphlets illustrating and describing their designs. The usual style of catalog pamphlets adopted by this company is followed in this case, beginning wth a description of the Atlantic Type locomotive and presenting the advantages which the type offers for fast passenger service. All of the designs presented in the book, to the number of twenty-six are illustrated with half-tone engravings, each engraving being accompanied by a table giving the leading dimensions of the design. The pamphlet also presents the chief dimensions of each design in tabular form, arranged in the order of the total weights of the locomotives. Railroad officials will find this arrangement very convenient in deciding upon the type and design of locomotives for any special conditions. It is understood that this series of pamphlets will ultimately cover the entire product of these builders.

HIGH DUTY METAL.—The Western Tube Company, Kewanee, Ill., is using a pamphlet descriptive of some researches and experiments which it has recently made in attempting to find a bronze mixture, for use in valves and pipe fittings, which will

maintain its strength under very high temperatures. These experiments were very interesting and showed that the ordinary metal used for this purpose gave a drop in tensile strength of as much as 28 per cent. when raised to a temperature of 407 deg. Fahr., which is about the temperature of steam under 250 lbs. pressure. A number of other alloys were tested, with the final result of obtaining a metal which has been called a "high duty metal," which, when raised to a temperature of 407 deg. Fahr., shows a loss in tensile strength of only 5.6 per cent., giving an ultimate strength at that point of 31,627 lbs. per sq. in. Other tests with this metal showed that its wearing qualities were exceedingly good and that it was very tough and was able to resist shocks with much success. This company proposes to use this metal hereafter for their entire line of brass valves designed for pressures between 125 and 250 lbs., and will, if desired, furnish any of their products in this metal. The pamphlet contains an account of the tests and their results.

Statue of Matthias W. Baldwin.—A bronze statue of Matthias W. Baldwin has been placed on a pedestal in a small park facing the office building of the Baldwin Locomotive Works, at the intersection of Broad and Spring Garden Streets, Philadelphia, and was presented to the city through the Fairmount Park Art Association, with proper ceremonies, on June 2, 1905. The statue, which is of bronze and rests on a granite pedestal, is the work of Mr. Herbert M. Adams, of New York. The side of the pedestal facing Broad Street shows only the name "Baldwin," but on the opposite side is found the following inscription: "Matthias William Baldwin, MDCCXVI—MDCCCLXVI, founder of the Baldwin Locomotive Works. His skill in the mechanic arts, his faithful discharge of the duties of citizenship, his broad philanthropy and unfailing benevolence and his devotion to all Christian work placed him foremost among the makers of Philadelphia."

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Kobbe Company.—This company has removed its general offices and works from Trumansburg, N. Y., to Ithaca, N. Y. Their New York office is located at 90-92 W. Broadway.

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Railway Education.—The fall term of the evening courses in railway education of the University of Chicago opened on October 1st. These courses, of which there are a large number covering all different departments of railroading, occupy one evening a week from October to April inclusive. A fee of $25 is charged for each course. Circulars of complete information can be obtained from the Secretary of Courses in Railroad Education, 422 Grand Central Station, Chicago, Ill.

A Journal of Industrial Opportunities.—The Machine Tool Pocket List, formerly published by Angus Ballard Company, has been purchased by the George H. Gibson Company, advertising engineers, Park Row Building, New York City. The size of the book will be increased to 4 x 9 ins., and the Buyers' Finding List of Machine Tools and Supplies will be enlarged and improved. The List will be published with "Manufacturing," a journal in which important patents and other industrial opportunities are described and listed. Brief articles to the manufacturers of machinery will be found in each issue.

American Locomotive Company.—The fifth annual report of this company shows that the gross earnings for the last fiscal year were over 42½ million dollars, an increase of 18 million dollars over the previous year. The net earnings were nearly 6½ million dollars, an increase of over two million dollars. During the year over one million dollars was expended for additions and betterments of plants and two million dollars was set aside for an extraordinary improvement and betterment fund. Seven per cent. was paid on the preferred stock and 1¼ per cent. on the common stock, leaving a surplus of over one million dollars, an increase of one-half million over last year. During the year a subsidiary company, known as the American Locomotive Automobile Company was organized and Mr. Herman F. Ball has been secured as vice-president and is in charge of its operation. An excellent automobile plant has been constructed at Providence, R. I. A plant for the building of the Atlantic steam shovels has been erected at Richmond, Va.

Westinghouse Electric & Manufacturing Company.—The report of the board of directors to the stockholders of this company covering a period of six years, which was recently issued, contains some very interesting figures and information. The total number of employees exclusive of the selling organization has increased from less than 8,000 in 1901 to nearly 15,000 in 1906. The number of men employed in the engineering department has increased from 420 to 629 in the same period, and by means of better organization, each man handles a larger amount of work than was the case five years ago. The report states that at least 45 per cent. of the engineering force is continually engaged in development work. The report of the sales department shows that the sales of the company have increased from 12½ million dollars in 1901 to nearly 25 million dollars in 1906, with an indication of over 34 million dollars for the current year. This does not include the sales of subsidiary companies. The sales for the electric pneumatic switch system show an increase of 60 per cent. over any previous year; sales of railway motors have increased over 51 per cent. over any previous year. The report states that there are six railways now successfully using the single-phase system, and that the installation of the same system on five other large roads is now in progress. The sales of the detail and supply department has increased over 90 per cent. during the past year. The general balance sheet shows that the value of properties and plants owned is over 11 million dollars and that the surplus is over 11½ million dollars. The gross earnings for the six years were $114,618,537, and the net earnings were over $17,000,000

Electrical Equipment for the Hudson Company's Tunnels.—The construction work on the twin tunnels of the Hudson Company, connecting Jersey City with New York under the North River, was finished about a year ago and the work on the electrification is now under way. Fifty electric cars will be operated, taking their power from a third rail. Each tunnel has a single track and the cars will be operated in trains by the Sprague General Electric multiple unit control system. The power station, which will be located on the New Jersey side between Jersey City and Newark, will contain two 3,000 k.w., 11,000 v. generators and two 6,000 k.w., 11,000 v. generators, each being direct connected to Curtis steam turbines. This power will be distributed at high voltage to three sub-stations where the current will be stepped down to 650 volts direct current through transformers and rotary converters. Two of these sub-stations will be located in New York and one in Jersey City. All of the electrical equipment will be furnished by the General Electric Company. The American Locomotive Company will furnish the 50-motor and 50-trailer trucks for the cars, designs of which are now being prepared. Each motor truck will carry two 160-h.p. motors, which will be geared to one wheel on each axle, the wheel hub being extended to take the gear for the motor. Both types of trucks will be of the bar frame, swing bolster design, the bolsters being of rolled steel between transoms of channel iron and sustained by four three-point hangers. This type of suspension will allow the bolsters a good lateral motion and utilize the weight of the truck to restore the hangers to their proper position without the use of springs. The motor trucks will have 34½-in. wheels and 5 x 9½-in. journals. The trailer trucks will have 30-in. wheels and 4¼ x 9½-in. journals.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL
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COLE FOUR-CYLINDER BALANCED COMPOUND PACIFIC TYPE LOCOMOTIVE.

NORTHERN PACIFIC RAILWAY.

40,000th of the American Locomotive Company.

On November 2d, the American Locomotive Company invited a party of guests to visit its Schenectady Works for the purpose of inspecting two very large and powerful Pacific type locomotives just completed for the Northern Pacific Railway Company. These two engines complete the total number of locomotives built by all of the works of this company to 40,000 and this method was taken of celebrating the event.

The locomotives are of the Cole balanced compound design and are the first of the Pacific type to be built with this arrangement of cylinders, all previous Cole compounds having been of the Atlantic type. They have the further distinction of being the heaviest of the type ever built, weighing 240,000 lbs. total with 157,000 lbs. on drivers. Other noticeable features embodied in the design are the use of the combustion chamber, of the same arrangement as was applied to the large order of 70 locomotives illustrated in the previous issue of this journal, and the use of the Walschaert valve gear.

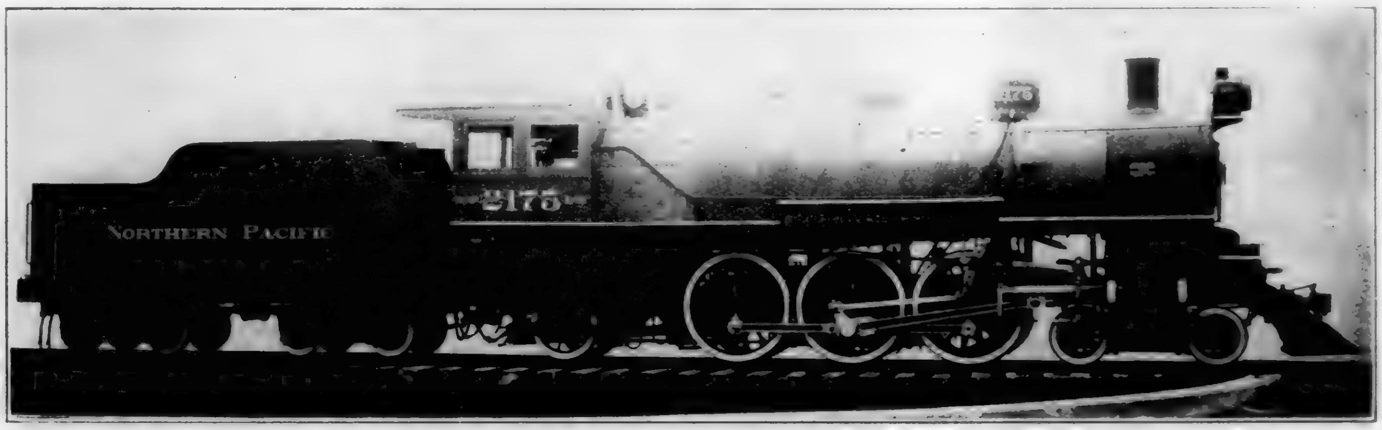
The table on page 414 permits a comparison to be made between these leaders of their type and others of the balanced compound Pacific type previously built, as well as several different Cole compounds of the Atlantic type. Reference can be made to the article mentioned above (Oct., 1906, p. 395), for a comparison with the other Pacific type locomotives now owned by the Northern Pacific Railway Company, this one making the fourth arrangement of practically the same size and weight, giving this company Pacific type locomotives as follows: Simple engines without combustion chamber or superheater; simple engines with combustion chamber and without superheater; simple engines with combustion chamber and superheater, and balanced compound engines with combustion chamber and without superheater. This offers an exceptional chance for developing the advantages or disadvantages of these several features by direct comparison while operating under identical conditions.

In examining the table of comparative dimensions given herewith, it should be remembered that the introduction of the combustion chamber largely reduces the actual total square feet of heating surface, and hence all ratios based on that figure. In these ratios the square feet of heating surface is used as an indication of boiler capacity, and reference should be made to the comments on the advisability of using a combustion chamber, given on page 393 of our October issue, where it is stated that one year's experience had indicated that there was no reduction in boiler capacity in spite of the large reduction of actual total heating surface, hence proper consideration of this feature should be given in comparing these locomotives with others not so arranged.

The illustrations show all the more important details very clearly and a careful examination of them will give a good idea of the prominent features of this interesting design.

The illustration showing the boiler has not been included as the boiler on this locomotive is practically identical with the one used on the previous Pacific type engines, the details of which were shown on page 394 of the October issue. The only change made has been in placing the cylinders 13 ins. farther ahead, making them 32 ft. 11 ins. from the front edge of the mud ring and 43 ins. ahead of the flue sheet. The front barrel sheet has been increased in length to make up this difference. In other respects the boilers are identical, and reference can be made to the previous article for a description of and comment on the design.

The Cole system of compounding is similar to the older DeGlehn arrangement in that it places one pair of cylinders, which in this case are the high pressure ones, between the frames and ahead of the other pair, connecting them to the front cranked axle, while the outside pair are connected to the second pair of drivers in the usual manner. It differs from that design, however, in having but one system of valve motion, which operates two piston valves one for each cylinder through one valve stem.



COLE FOUR-CYLINDER BALANCED COMPOUND PACIFIC TYPE LOCOMOTIVE, NORTHERN PACIFIC RY.

The design was first brought to public notice in 1904, when an Atlantic type locomotive with the Cole system of compounding was built by the American Locomotive Company for the New York Central and Hudson River R. R., and exhibited at the St. Louis exposition where it was tested on the Pennsylvania Railroad's locomotive testing plant. It made an exceptionally good record, and was the only locomotive tested which was able to maintain 75 miles per hour for one full hour. Its operation was most satisfactory from all points of view, and the results obtained showed the design to be excellent in all respects. Reference can be made to the report of these tests published by the Pennsylvania Railroad Company for the record given by this locomotive. Since that time this design has been specified by two other companies for Atlantic type locomotives. Descriptions of these engines were published in this journal in 1905, page 287, and 1906, page 73, and for the New York Central locomotive, 1904, pages 166 and 241.

In brief, the cylinders in this design consist of a pair of low pressure, which was cast with a saddle and valve chambers, and are connected to the frames and boiler in a manner very similar to a simple engine and a pair of high pressure cylinders which are between the frames and drive on a crank axle and are in a separate casting fastened to the frames and saddle ahead of the low-pressure cylinders. The guides for the high-pressure cylinders are located beneath the low-pressure saddle. A passage is arranged for conveying steam

maintain its strength under very high temperatures. These experiments were very interesting and showed that the ordinary metal used for this purpose gave a drop in tensile strength of as much as 28 per cent. when raised to a temperature of 407 deg. Fahr., which is about the temperature of steam under 250 lbs. pressure. A number of other alloys were tested, with the final result of obtaining a metal which has been called a "high duty metal," which, when raised to a temperature of 407 deg. Fahr., shows a loss in tensile strength of only 5.6 per cent., giving an ultimate strength at that point of 31,627 lbs. per sq. in. Other tests with this metal showed that its wearing qualities were exceedingly good and that it was very tough and was able to resist shocks with much success. This company proposes to use this metal hereafter for their entire line of brass valves designed for pressures between 125 and 250 lbs., and will, if desired, furnish any of their products in this metal. The pamphlet contains an account of the tests and their results.

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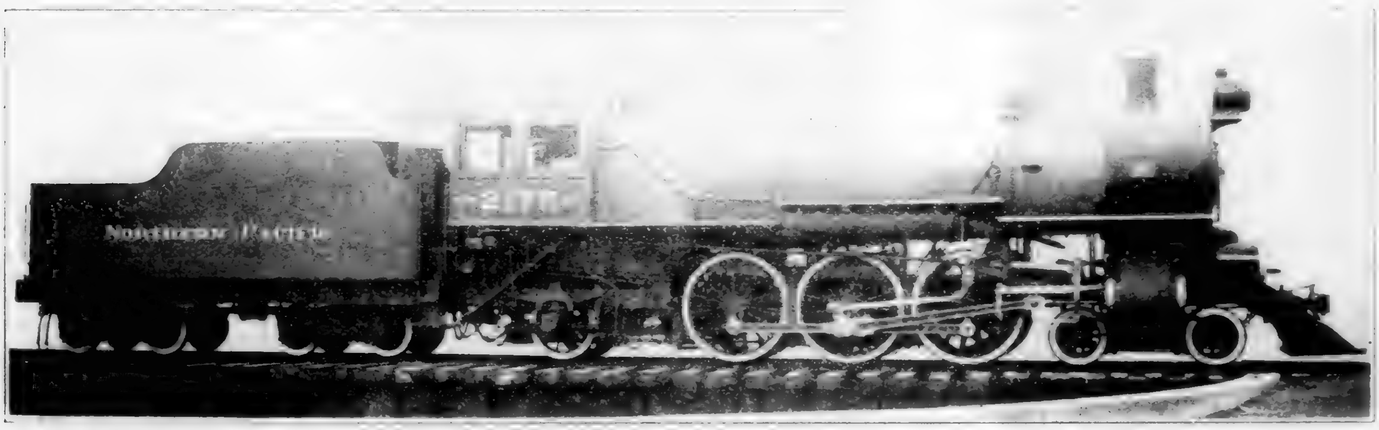
The illustration showing the boiler has not been included as the boiler on this locomotive is practically identical with the one used on the previous Pacific type engines, the details of which were shown on page 394 of the October issue. The only change made has been in placing the cylinders 13 ins. farther ahead, making them 32 ft. 11 ins. from the front edge of the mud ring and 13 ins. ahead of the flue sheet. The front barrel sheet has been increased in length to make up this difference. In other respects the boilers are identical and reference can be made to the previous article for a description of and comment on the design.

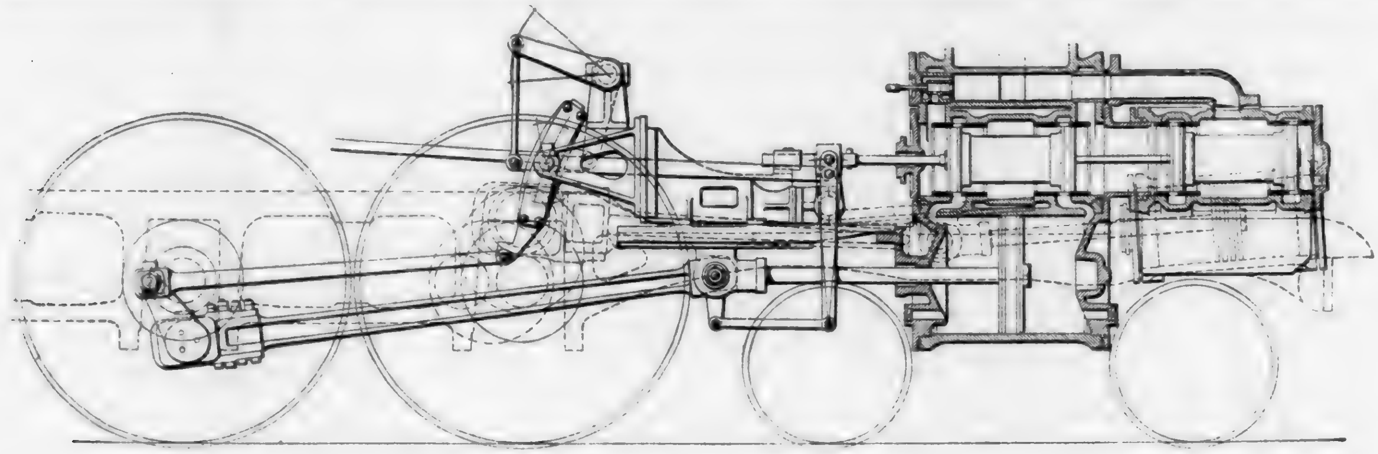
The Cole system of compounding is similar to the older DeGlehn arrangement in that it places one pair of cylinders, which in this case are the high pressure ones, between the frames and ahead of the other pair, connecting them to the front cranked axle, while the outside pair are connected to the second pair of drivers in the usual manner. It differs from that design, however, in having but one system of valve motion, which operates two piston valves one for each cylinder through one valve stem.



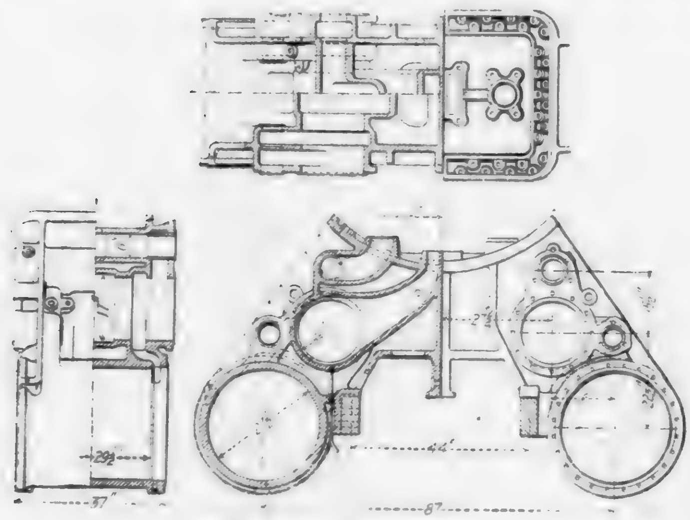
COLE FOUR-CYLINDER BALANCED COMPOUND PACIFIC TYPE LOCOMOTIVE—NORTHERN PACIFIC RY.

The design was first brought to public notice in 1904, when an Atlantic type locomotive with the Cole system of compounding was built by the American Locomotive Company for the New York Central and Hudson River R. R. and exhibited at the St. Louis exposition where it was tested on the Pennsylvania Railroad's locomotive testing plant. It made an exceptionally good record, and was the only locomotive tested which was able to maintain 75 miles per hour for one full hour. Its operation was most satisfactory from all points of view and the results obtained showed the design to be excellent in all respects. Reference can be made to the report of these tests published by the Pennsylvania Railroad Company for the record given by this locomotive. Since that time this design has been specified by two other companies for Atlantic type locomotives. Descriptions of these engines were published in this journal in 1905, page 287, and 1906, page 73, and for the New York Central locomotive, 1904, pages 166 and 241.

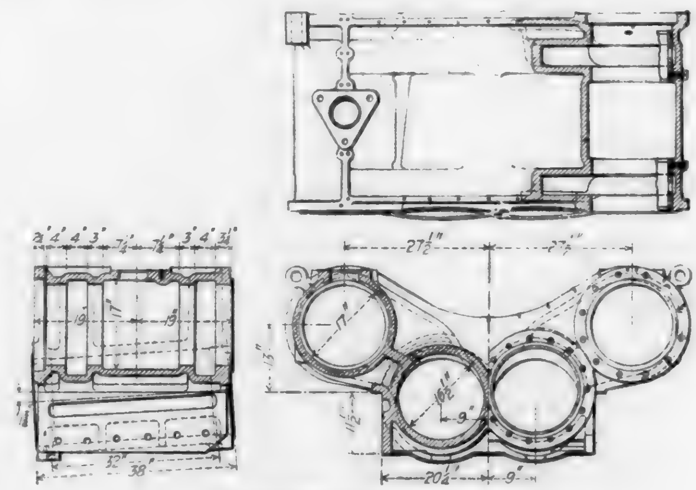
In brief, the cylinders in this design consist of a pair of low pressure, which was cast with a saddle and valve chambers, and are connected to the frames and boiler in a manner very similar to a simple engine and a pair of high pressure cylinders which are between the frames and drive on a crank axle and are in a separate casting fastened to the frames and saddle ahead of the low-pressure cylinders. The guides for the high-pressure cylinders are located beneath the low pressure saddle. A passage is arranged for conveying steam



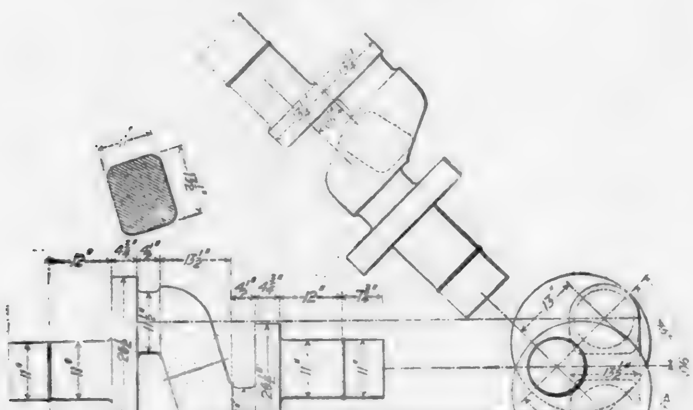
ELEVATION OF VALVES AND VALVE GEAR.



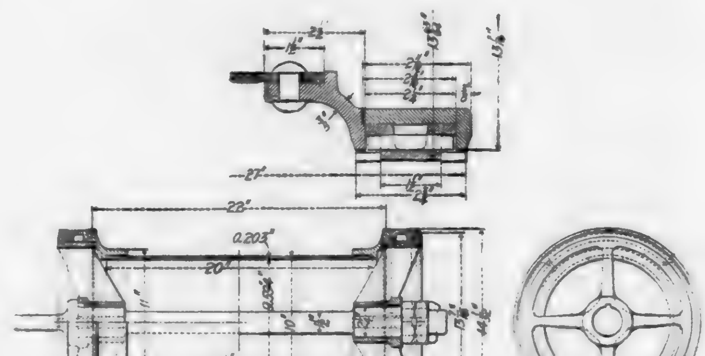
LOW-PRESSURE CYLINDERS.



HIGH-PRESSURE CYLINDERS.



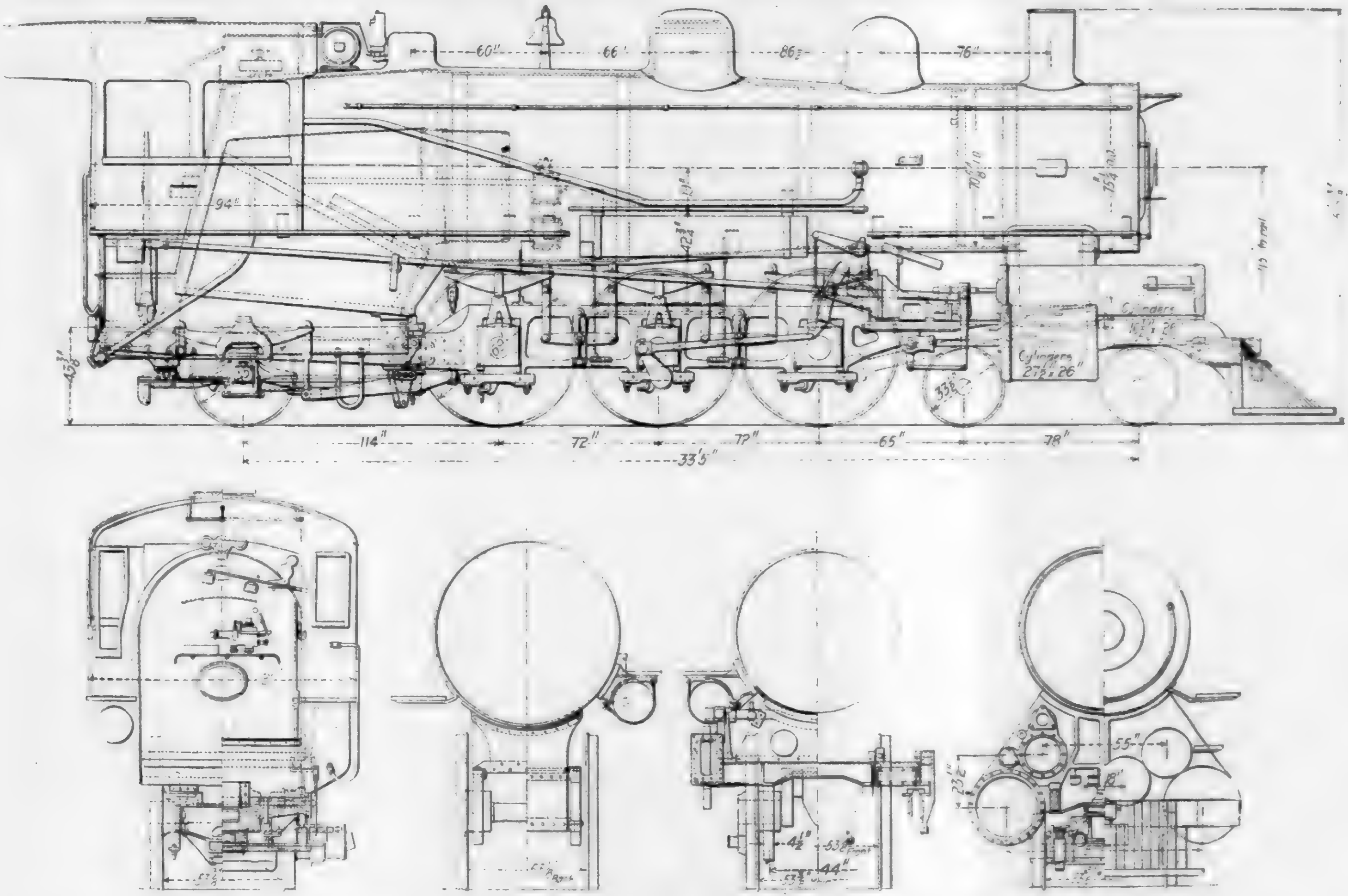
CRANK AXLE.



PISTON VALVE.

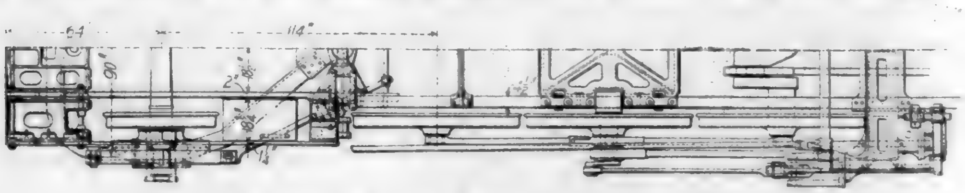
FRAMES.

DETAILS OF COLE FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE, NORTHERN PACIFIC RAILWAY.



ELEVATION AND SECTIONS OF FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE. NORTHERN PACIFIC RAILWAY.

from the saddle to the high pressure valve chamber through an elbow pipe heavily lagged and connecting through ground joints. An examination of the drawings of the cylinders will illustrate the details. A difference is noticed in this latest design over that used formerly, in that the high pressure cylinders are somewhat raised and slightly inclined. This is done, of course, for clearance of the front truck since connecting to 69 in. wheels, in a direct line, would throw the high pressure cylinder too low for the proper clearance. All previous Cole compounds have had wheels of 78 in. or more in diameter, and hence it was not necessary to incline the cylinders. The valve chamber is in a horizontal line, being a continuation of the low pressure chamber. Two 14-inch hollow piston valves are used, the one for the high pressure being arranged for inside admission, while the low pressure is outside admission and central exhaust. A starting valve is provided which will allow live steam at a reduced pressure to be admitted to the low pressure cylinder when desired. Both valves are connected to the same stem and have, of course, simultaneous movement. This stem is driven from a simple arrangement of Walschaert valve gear, the construction of which is clearly shown in one of the illustrations. There is, in this case, but one reverse shaft, the reach rod extending directly from the reverse lever to the end of a downwardly extending arm of this shaft, which is carried in bearings supported from the guide yoke, and is offset in the center to clear the shell of the boiler. The guide yoke itself is a large and stiff, although very light, steel casting spanning the frames and supporting the back end of the low pressure guides and all parts of the valve gear.



PLAN SHOWING FRAME BRACING AND TRAILER TRUCK.

The frames, which are shown in one of the illustrations, are in two sections, the trailer frames being of a double plate design with the wheel between and connect to the main frames just back of the third driver, at which point there is a cross frame stiffening casting, to which the pivot of the radial truck trailer frame is connected, and which also includes the boiler bearings. The main frames are of the bar type 4½ ins. wide and 6 ins. deep over pedestals and 5 ins. deep at the top rail in other places. The depth is increased to 8½ ins. between the front pedestal and low pressure cylinder connection, and is narrowed to 2 ins. in width and 11½ ins. in depth where the high pressure cylinders are connected. An exceedingly broad steel casting is placed across between the top rails just above the pedestal of the second pair of drivers. This is a light but very stiff casting, and ties and stiffens the frames securely at this point. The special design of cast steel pedestal binder will be noticed in the illustration.

The illustration shows the crank axle which is on the forward pair of drivers and is of a solid forged design. The center portion, which includes the high pressure main rod journals, is connected to the wheel fit and driving journal portions by two circular sections 4¾ ins. thick. The high pressure journals are 4½ ins. wide by 11½ ins. in diameter, and the inclined part between them is rectangular in section 11 by 13½ ins. The cranks are arranged at 90 degs. between the two high pressure and 180 degs. between the high and low pressure on the same side of the locomotive. The trailer truck is of the radial roller-bearing design, which has been success-

Owner	N. P.	O., R. & N.	A., T. & S. F.	N. P.	Erie.	P. R. R.	N. Y. C.
Type of compound	Cole.	Baldwin.	Baldwin.	Simple.	Cole.	Cole.	Cole.
Wheel arrangement	4—6—2	4—6—2	4—6—2	4—6—2	4—4—2	4—4—2	4—4—2
Total weight	240,000 lbs.	231,300 lbs.	226,700 lbs.	223,000 lbs.	206,000 lbs.	200,500 lbs.	200,000 lbs.
Weight on drivers	157,000 lbs.	143,600 lbs.	151,900 lbs.	146,300 lbs.	115,000 lbs.	117,200 lbs.	110,000 lbs.
Size of cylinders	16½&27½ x26 in.	17&28x28 in.	17&28x28 in.	22x26 in.	15½&26 x26 in.	16&27x26 in.	15½&26 x26 in.
Diameter of drivers	69 in.	77 in.	73 in.	69 in.	78 in.	80 in.	79 in.
Steam pressure	220 lbs.	200 lbs.	220 lbs.	200 lbs.	220 lbs.	205 lbs.	220 lbs.
Tractive effort comp.	30,340 lbs.	28,300 lbs.	32,800 lbs.	31,000 lbs.	23,860 lbs.	23,300 lbs.	24,000 lbs.
Total heating surface	2,908 sq. ft.	3,055 sq. ft.	3,595 sq. ft.	2,978.4 sq ft.	3,634.7 sq. ft.	2,861.6 sq. ft.	3,465 sq. ft.
Firebox heating surface	241.8 sq. ft.	179 sq. ft.	192.8 sq. ft.	241.7 sq. ft.	181.1 sq. ft.	181.4 sq. ft.	198 sq. ft.
Length of tubes	16 ft. 9 in.	20 ft.	20 ft.	16 ft. 9 in.	17 ft.	16 ft. 3 in.	16 ft.
Grate area	43.5 sq. ft.	49.5 sq. ft.	53 sq. ft.	43.5 sq. ft.	56.5 sq. ft.	55.5 sq. ft.	50.23 sq. ft.
Weight on drivers ÷ tractive effort	5.18	5.07	4.63	4.72	4.82	5	4.58
Total weight ÷ total heating surface	82.5	75.5	63	75	56.5	70	57.5
Tractive effort × diam. drivers ÷ total H. S.	720	713	666	720	513	650	546
Vol. equivalent simple cylinders	9.9	11.5	11.5	11.4	8.93	9.4	8.93
Total H. S. ÷ vol. equivalent cylinders	294	265	312	261	405	305	387
Grate area ÷ vol. equivalent cylinders	4.3	4.3	4.62	3.8	6.33	5.9	5.62
Reference in AMERICAN ENGINEER	This issue	1905, p. 246	1905, p. 454	1906, p. 392	1905, p. 287	1906, p. 73	1904, p. 166

COMPARATIVE DIMENSIONS OF BALANCED COMPOUND LOCOMOTIVES.

fully built and applied by this company for a number of years. The general dimensions, weights and ratios are as follows:

COLE BALANCED COMPOUND PACIFIC TYPE LOCOMOTIVE.

NORTHERN PACIFIC RAILWAY.

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Passenger
Fuel	Bit. coal
Tractive effort	30,340 lbs.
Weight in working order	240,000 lbs.
Weight on drivers	157,000 lbs.
Weight of engine and tender in working order	380,500 lbs
Wheel base, driving	12 ft.
Wheel base, total	33 ft. 5 in.
Wheel base, engine and tender	62 ft. 10 in.

RATIOS.

Weight on drivers ÷ tractive effort	5.18
Total weight ÷ tractive effort	7.9
Tractive effort × diam. drivers ÷ heating surface	720
Total heating surface ÷ grate area	67
Firebox heating surface ÷ total heating surface, %	8.3
Weight on drivers ÷ total heating surface	53.8
Total weight ÷ total heating surface	82.5
Volume of equivalent simple cylinders	9.9 cu. ft.
Total heating surface ÷ volume equivalent cylinders	294
Grate area ÷ volume equivalent cylinders	4.3

CYLINDERS.

Kind	Balanced Compound
Number	4
Diameter and stroke	16½ & 27½ x 26

VALVES.

Kind	Piston
Diameter	14 in.
Greatest travel	6 in.
Outside lap	1 in.
Inside clearance	H. P., 5-16 in.; L. P., ⅜ in.
Lead in full gear	¼ in.

WHEELS.

Driving, diameter over tires	69 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	11 x 11½ in.
Driving journals, others, diameter and length	9½ x 12 in.
Engine truck wheels, diameter	33½ in.
Engine truck journals	6½ x 12 in.
Trailing truck wheels, diameter	45 in.
Trailing truck, journals	8 x 14 in.

BOILER.

Style	E. W. T.
Working pressure	220 lbs.
Outside diameter of first ring	72¼ in.
Firebox, length and width	96 x 65¼ in.
Firebox plates, thickness	⅜ in.
Firebox, water space	F4½-S -B4 in.
Tubes, number and outside diameter	306 2-in.
Tubes, length	16 ft. 9 in.
Heating surface, tubes	2,667 sq. ft.
Heating surface, firebox	241.8 sq. ft.
Heating surface, total	2,908.8 sq. ft.
Grate area	43.5 sq. ft.
Smokestack, diameter	18 in.
Smokestack, height above rail	15 ft. 5½ ins.
Center of boiler above rail	115 in.

TENDER.

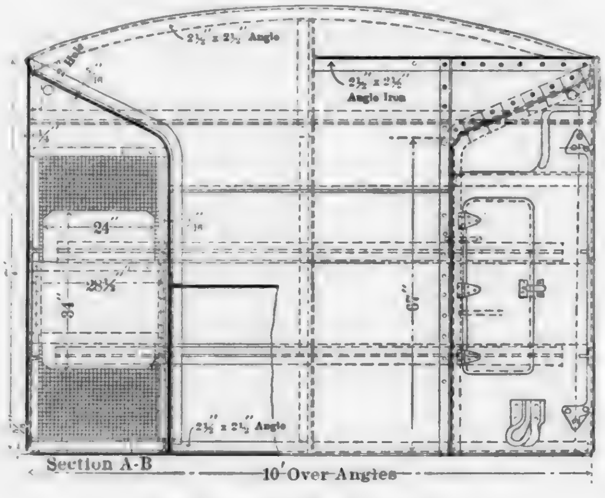
Tank	Water bottom
Frame	13-in. channels
Wheels, diameter	33¼ in.
Journals, diameter and length	5½ x 10 in.
Water capacity	7,000 gals.
Coal capacity	12 tons

POOL VS. REGULAR CREW.—If you examine the reports made to the Interstate Commerce Commission by the different trunk lines showing the amount of money expended to keep each locomotive in repair for the year ending June 30, 1905, you will find two of the large trunk lines where they keep regular crews on their engines making the best showing of all railroads in the United States, and these two roads have a reputation second to none in point of good service.—*Committee Report on Pooling Engines, Traveling Engineers' Association.*

7,000 GALLON TENDER.

LOUISVILLE & NASHVILLE RAILROAD.

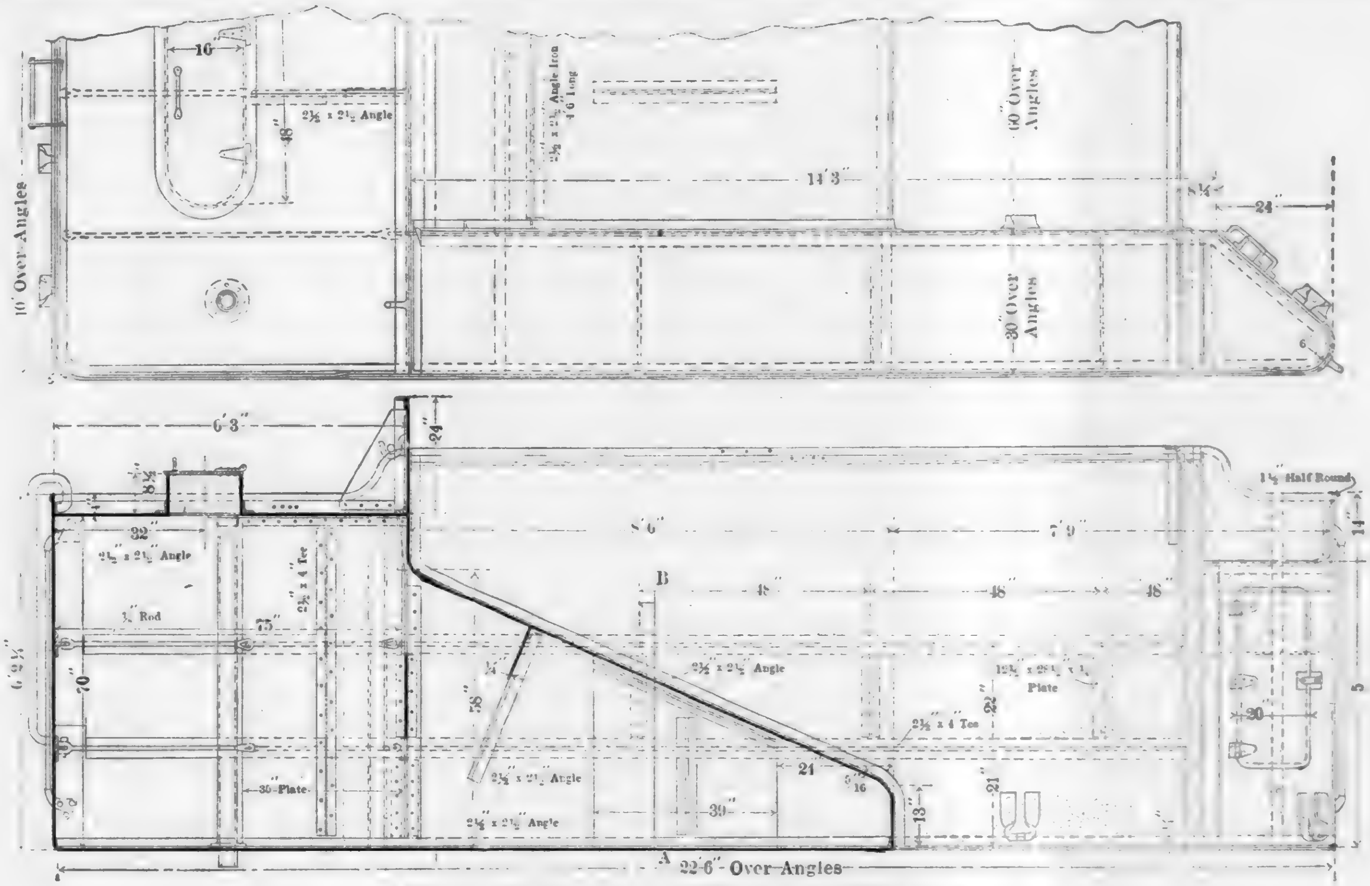
The standard 7,000-gal. tender of the Louisville & Nashville Railroad, illustrated herewith, has several interesting features of design. The sheets forming the sides of the coal space are in one piece, extending from the bottom of the tank to the top of the outside side sheets, to which they are riveted. This construction not only simplifies and reduces the cost of erection, but also reduces the amount of material required. It also presents a much neater and cleaner appearance than where the vertical part of the coal space side sheet is connected to the outside sheet by a slope sheet extending to the top of the side sheet and a horizontal sheet extending to the side sheet, both the slope and the horizontal sheets being riveted to an angle riveted to the top of the coal space side



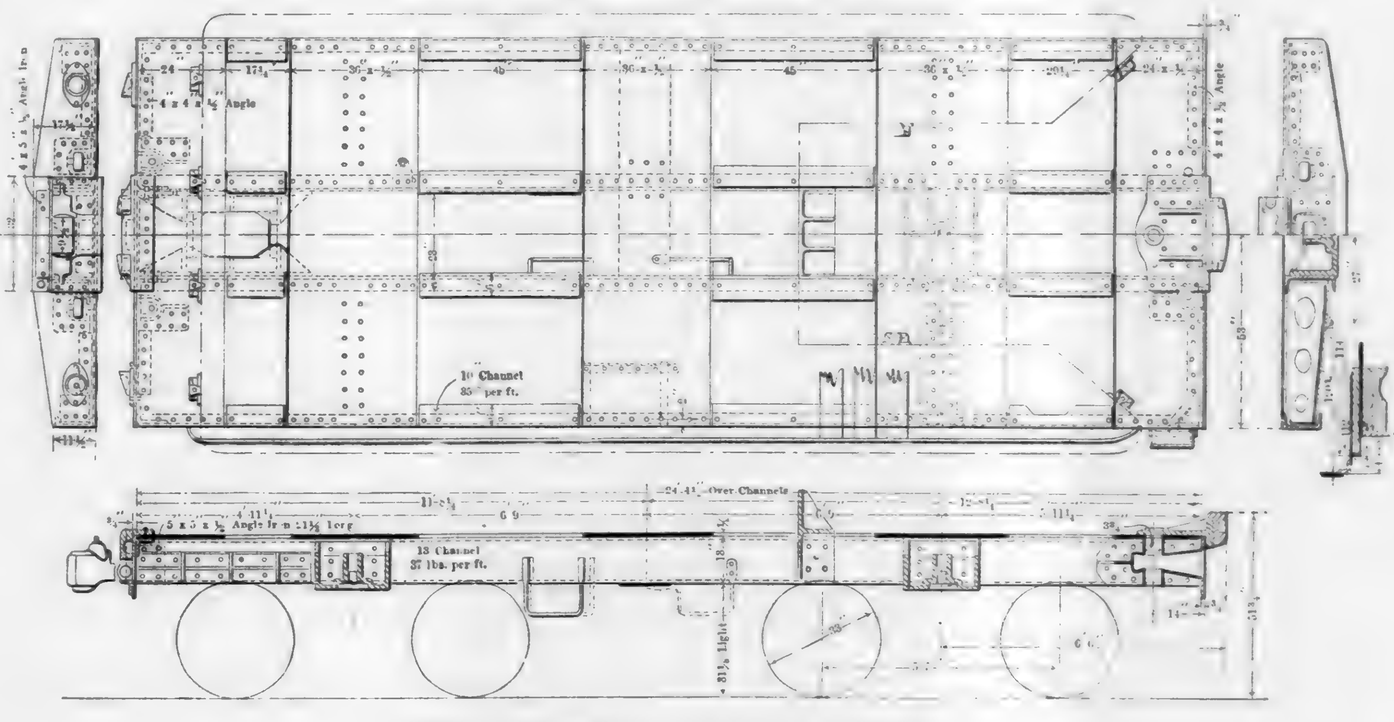
END ELEVATION OF TANK.

sheet. The vertical part of the sheet does not end where it is riveted to the slope sheet forming the bottom of the coal pit, but extends downward to the floor sheet, to which it is connected by an angle-iron, thus greatly stiffening the tank. Additional braces for the bottom of the coal space are also provided, as shown. The sides and ends of the tank are stiffened by the 2½x4-in. T's, which are riveted to them by 7-16-in. rivets, 6-in. pitch. The water in passing forward into the legs of the tank passes through the screens of 2¾x2¾-in. mesh, No. 11 B. W. G.

The center sills of the tender frame consists of 13-in. channels, 37 lbs. per foot, and the side sills are 10-in. channels, 35 lbs. per foot. The castings connecting the center sills at the bolsters are of cast steel, while those connecting the center and side sills are cast iron. Cover plates 36 ins. wide and ½ in. thick extend across the frame at the bolster, securely tying the various parts together. There is also a cover plate of this size extending across the top of the frame at the center and cover plates 24 ins. wide and ½ in. thick at each



7,000-GAL. TENDER TANK, LOUISVILLE & NASHVILLE R. R.



7,000-GAL. TENDER FRAME, LOUISVILLE & NASHVILLE R. R.

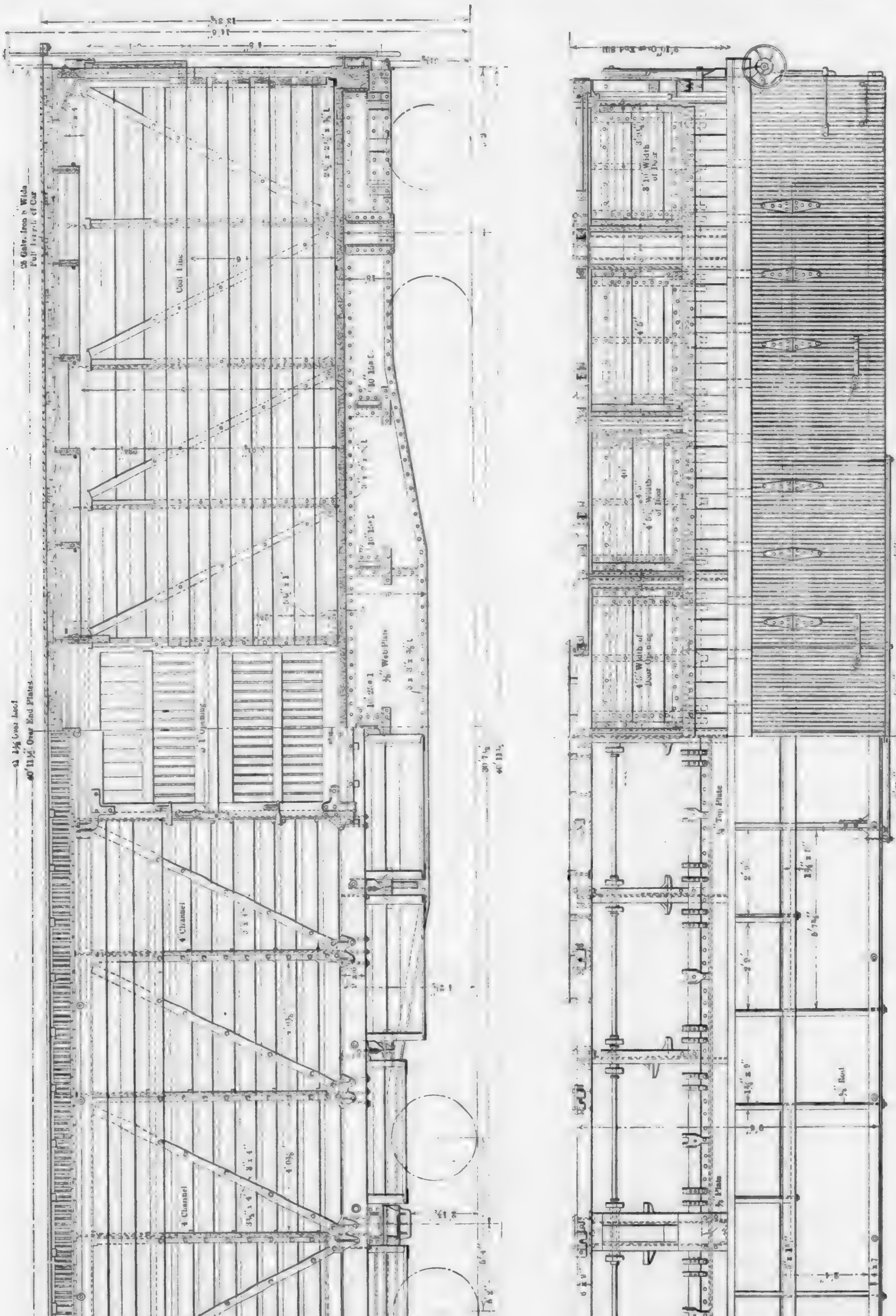
end. The end sills are ¾-in. plates connected to a ½-in. cover plate by 4 x 4 x ½-in angles, and to the center and side sills by heavy angle plates, as shown. The center sills are spaced 23 ins. apart, and the steel draft casting at the rear end is arranged to take the Session-Standard friction draft gear. We are indebted for information to Mr. T. H. Curtis, superintendent of machinery, and Mr. Walter H. Stearns, mechanical engineer.

The committee makes the following conclusions, and recommends as general principles of practice that:

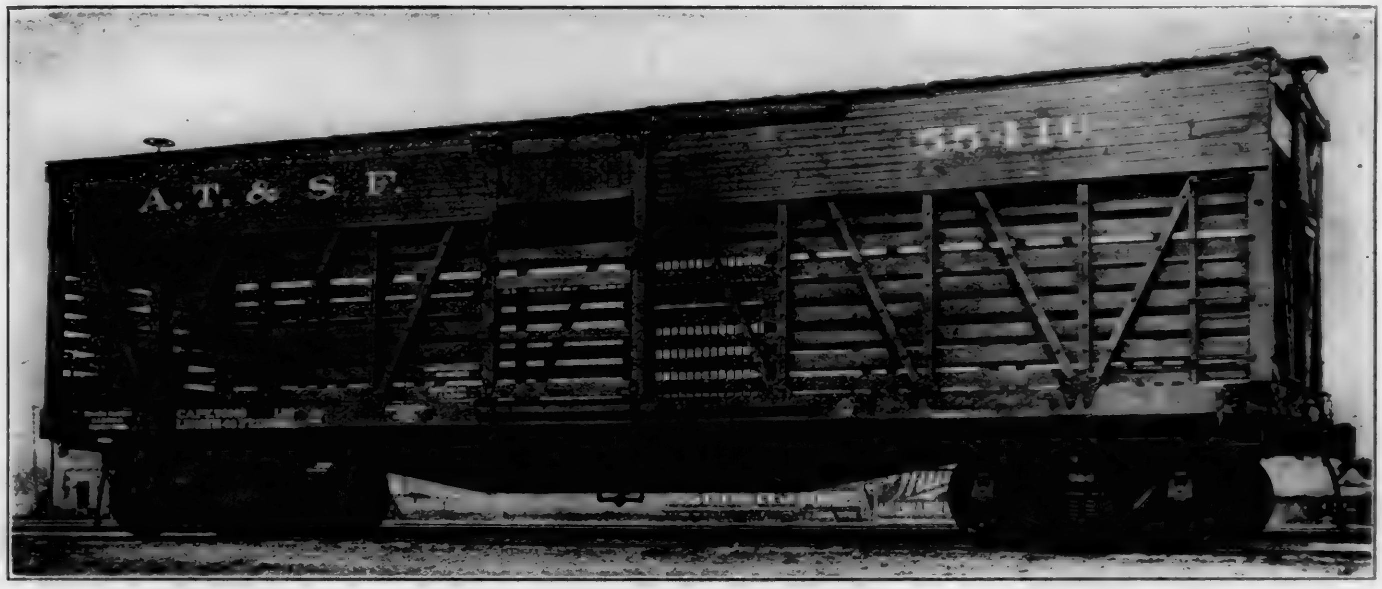
The circular form of an engine house is, in general, the preferable design, with possibly the following exceptions:

(a) At branch terminals, or similar points, where not more than three or four locomotives are housed at one time and where it is more economical to provide a "Y" track than a turntable, or where it is not necessary to turn the locomotives, a through rectangular house, with switches at one end only, may be desirable, or

(b) At shops where a transfer table is used and an engine house is to be added, and at special locations, the transfer table house may be desirable.—*American Railway Engineering and Maintenance of Way Association.*



35-TON STOCK AND COKE CAR WITH STEEL UNDERFRAME. ATCHISON, TOPEKA AND SANTA FE RY.



35-TON STOCK AND COKE CAR WITH STEEL UNDERFRAME—ATCHISON, TOPEKA & SANTA FE RAILWAY.

35-TON STEEL UNDERFRAME STOCK AND COKE CAR.

Atchison, Topeka & Santa Fe Railway.

The Atchison, Topeka & Santa Fe Railway has recently had built at the Madison works of the American Car & Foundry Company a number of 40-ft., 70,000-lb. capacity combination stock and coke cars with steel underframes. They have drop bottoms on each side of the center sills for the entire length of the car, and these, in connection with eight large doors in the roof, make it possible to handle coke as well as stock. The drop doors may be locked so that it is impossible for them to be opened accidentally. One of the cars filled to the roof with coke can be unloaded in about 15 minutes, this including the time for closing the doors and placing the car in service condition, but it is expected that this time will be considerably shortened when those who operate the doors become more familiar with them. The cars have doors just above the floor at the ends so that, in addition to handling stock, coke, coal, ties and lumber, they may readily be loaded with rail, pipe or other long material.

They weigh about 43,000 lbs. each and have the following general dimensions:

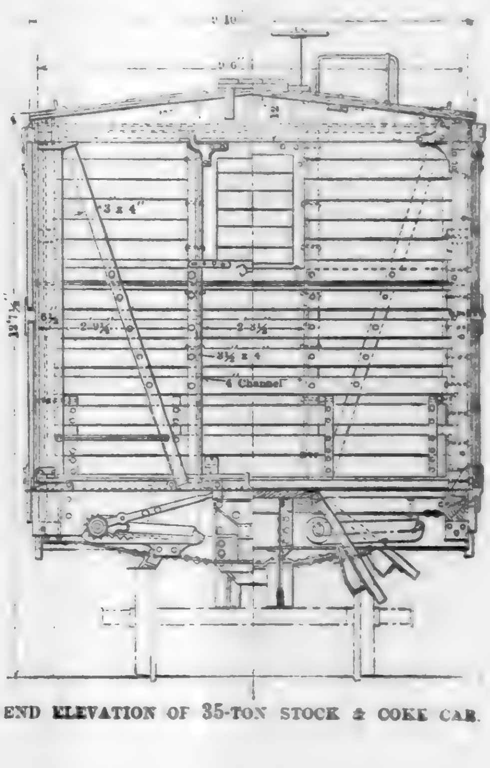
Length over end sills	40 ft 11½ ins.
Length inside	40 ft.
Width over side sills	9 ft. 6 ins.
Width at eaves	9 ft. 10 ins.
Width inside	8 ft. 8 ins.
Height inside, clear space	7 ft. 9 ins.
Height top of rail to top of running board	13 ft. 3¼ ins.
Height top of rail to top of eaves	12 ft. 7½ ins.
Wheel base of car	35 ft. 11½ ins.
Wheel base of truck	5 ft. 4 ins.
Distance between centers of trucks	30 ft. 7½ ins.

The center sills are continuous for the entire length of the car and consist of ⅝-in. plates with 3 x 3 x ⅝ in. angles riveted at the top, on the outside, and two 3 x 3 x ⅜ in. angles riveted at the lower edge, as shown on the drawing. These sills are reinforced by a ¼-in. cover plate and are 30 ins. deep for about 9 ft. at the center of the car, tapering to 18 ins. at the bolster. The side sills are of 6 x 9-in. long leaf yellow pine and are secured to the end sills by malleable iron pockets. At the center of the car is a 10-in. 25-lb. I beam, forming a crosstie and passing through the center sills, to which it is fastened by means of angle plates. The ends are cut to receive the side sills, to which they are attached by angle plates, which form a bearing for the sills. There are four other crossties, consisting of 10-in. channels, which are secured to the center and side sills in like manner.

The body bolsters are built up of pressed steel diaphragms, those between the center sills being of ⅜-in. steel and those between the center and side sills of 5/16-in. steel. They are reinforced at both the top and bottom by ⅜-in. plates 14 ins. wide. The slots in which the door operating shaft works are reinforced by ⅜ x 2-in. plates, and there is a 3/16-in. pressed steel filler between the diaphragms.

The end sills are of 8 x 12-in. white oak, secured to the center and side sills, as shown. Miner tandem rigging is used. The floor supports, 5 x 4 ins., are bolted to the crossties, bolsters and sills. The flooring is 2 ins. thick, and is protected around the door openings by steel plates. A modified form of the Caswell drop-door mechanism is used. Ratchet levers at each end of the car operate 2-in. shafts. Pinions on these shafts engage with racks and, as the shafts are revolved, they move inward or outward, thus opening or closing the doors, as the case may be. The shafts are fitted with roller bearings, which come in contact with the door, as shown on the drawing.

The side posts are 3½ x 4-in. and the corner posts 6½ x 6½-in. The side and end posts are plated on one side with 4-in. channels, secured to them by ½-in. bolts. The ends of the posts are fitted to malleable iron shoes and caps. The side door openings are 5 ft. 1 in. x 7 ft. 9 ins.; the end door openings are 2 ft. 3½ ins. x 2 ft. 10 ins. There are eight roof doors, each having an opening 2 ft. 4 ins. x 5 ft. 7¾ ins. The roof



END ELEVATION OF 35-TON STOCK & COKE CAR.

door openings are plated with iron and provided with water grooves. The trucks are the standard Santa Fe type for 35-ton freight cars. We are indebted for drawings and information to Mr. A. Lovell, superintendent of motive power, and Mr. E. Posson, engineer of car construction.

POWER HOUSE WITH PAINT STORE HOUSE IN FOREGROUND,—COACH SHOP AT THE LEFT.

WALSCHAERT VALVE GEAR.—Engine failures due to the breaking of valve motion connections during twelve months' service have been very slight. With fifteen engines equipped with the Walschaert valve gear we have had only three failures that were chargeable to valve motion failing, while with engines equipped with the Stephenson link motion we have had at least three times as many failures due to the link motion getting out of order.—*O. H. Rehmeyer, before the Traveling Engineers' Association*

TECHNICAL INSTRUCTION FOR RAILWAY EMPLOYEES.—Mr. J. F. Dunn, superintendent of motive power of the Southern Pacific Lines East of Sparks, has arranged with the University of Nevada at Sparks to establish classes for apprentices to be held every Monday and Tuesday mornings from 7 to 9 o'clock, and also for mechanics, car men, etc., to be held every Monday and Tuesday evenings from 7 to 9 o'clock. The classes will receive instruction in arithmetic, elementary mechanics, mechanical drawing, link motion and valve gears.

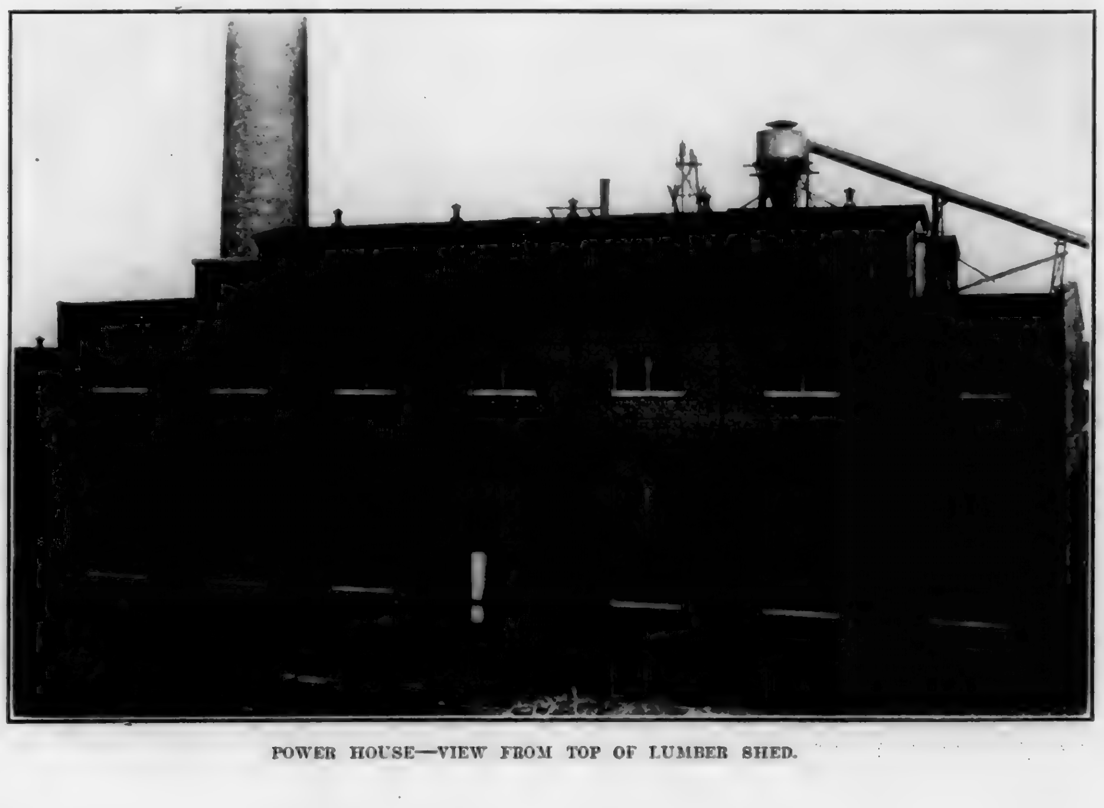
SOUTH LOUISVILLE SHOPS.

LOUISVILLE & NASHVILLE RAILROAD.

III.

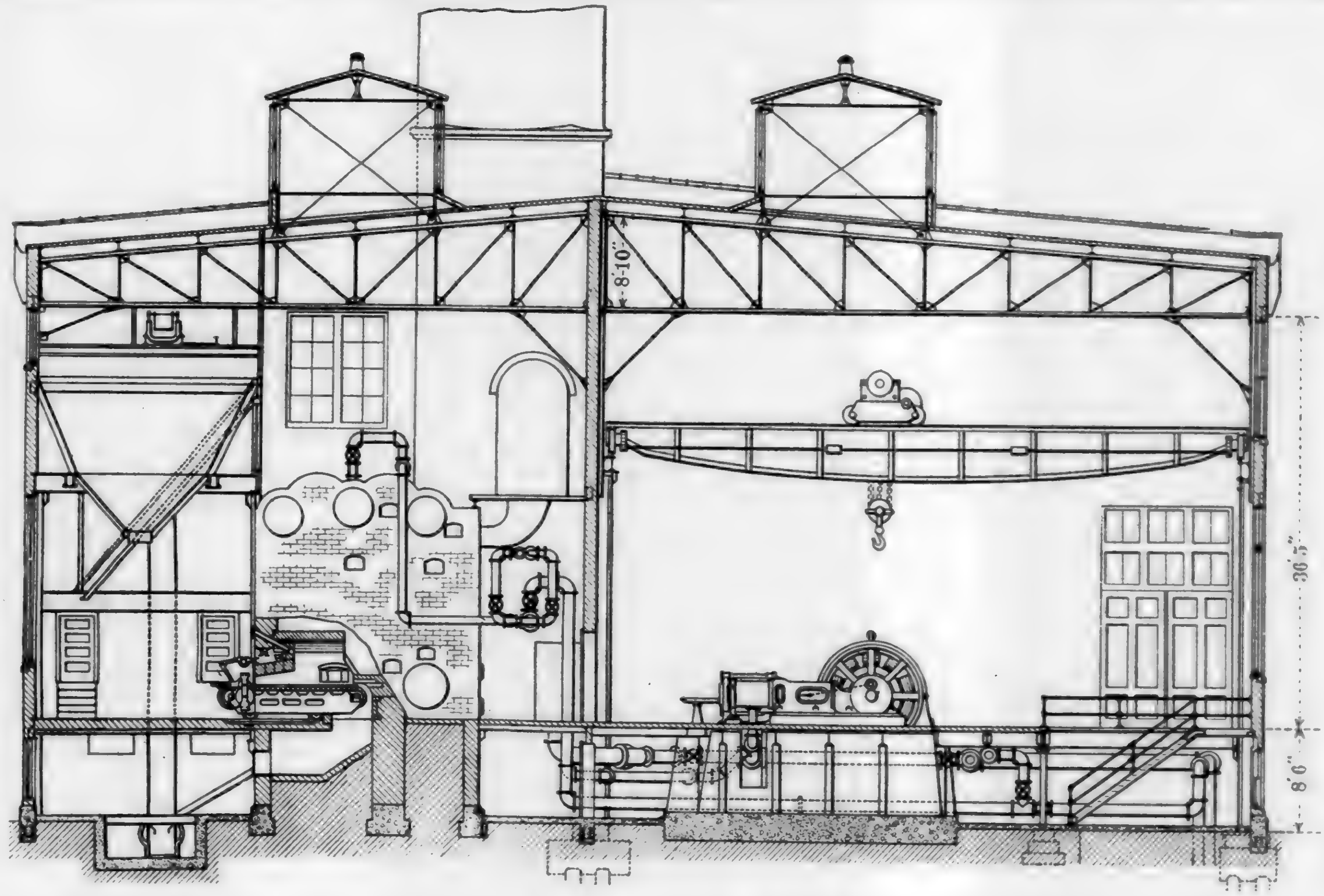
POWER HOUSE.

The power house, while it is apparently located a considerable distance south of the center of gravity of the power distribution, is not as far from it as would appear, since the amount of power required to operate the machines and the shaving exhaust system in the planing mill is quite large compared to that used in any of the other shops, not excepting the locomotive shop. Condensors were not installed, as practically all of the exhaust steam is used by the heating system and in the dry kiln. The piping is very carefully arranged to take care of any emergency and prevent a shutdown in case of accident.



POWER HOUSE—VIEW FROM TOP OF LUMBER SHED.

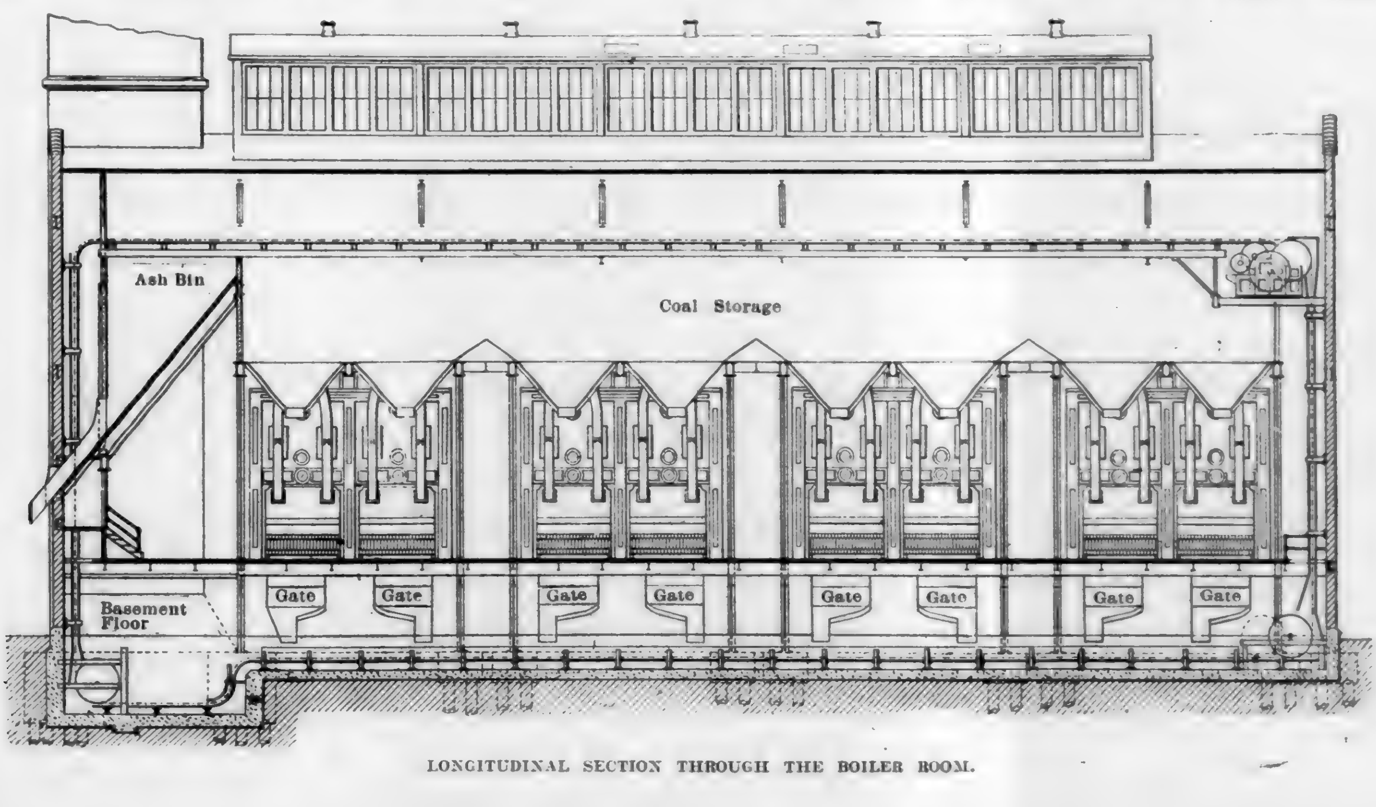
Building.—The power house is a steel frame brick building, 110 ft. by 141 ft. 4 ins., divided by a 13-in. brick wall into a boiler room 48 ft. 8 ins. by 139 ft. 2 ins. and an engine room 58 ft. 1 in. by 139 ft. 2 ins. Over each room is a monitor 7 ft. 10 ins. high and about 15 ft. wide, extending almost



CROSS-SECTION THROUGH ENGINE AND BOILER ROOM.

the entire length of the building. The engine room floor is 8 ft. 10½ ins. above grade and the height from the floor to the underside of the roof trusses is 36 ft. 5 ins. The engine room is equipped with a 5-ton traveling crane (56-ft. span), operated by hand, the runways of which are supported by columns independent of those of the building. The roof purlins consist of 10-in 25-lb. I beams, the wall and ridge purlins of 10-in. 15-lb. channels and the rafters of 2¼ by 2¼ 4.9-lb. T's. A composition roofing is used.

The floor is of concrete, supported by 15-in. I beams, which are in turn supported by cast-iron columns and, wherever possible, by the machinery foundations. The floor of the basement is slightly above grade and consists of concrete laid on a bed of cinders. The basement is lighted by a number of small windows. The window sills are of concrete, and all wood in connection with the windows and doors is covered with galvanized iron, thus making it fireproof. The wainscoting of the engine room is 9 ft. high and of brown pressed



LONGITUDINAL SECTION THROUGH THE BOILER ROOM.

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POWER HOUSE, WITH PAINT STORE HOUSE IN FOREGROUND.—COACH SHOP AT THE LEFT.

Walschaert Valve Gear.—Engine failures due to the breaking of valve motion connections during twelve months' service have been very slight. With fifteen engines equipped with the Walschaert valve gear we have had only three failures that were chargeable to valve motion failing, while with engines equipped with the Stephenson link motion we have had at least three times as many failures due to the link [illegible] out of order.—*O. H. Rehmeyer, before the Traveling Engineers' Association.*

Technical Instruction for Railway Employees.—Mr. J. F. Dunn, superintendent of motive power of the Southern Pacific Lines East of Sparks, has arranged with the University of Nevada at Sparks to establish classes for apprentices to be held every Monday and Tuesday mornings from 7 to 9 o'clock and also for mechanics, car men, etc., to [illegible] Monday and Tuesday evenings from 7 to 9 o'clock. The classes will receive instruction in arithmetic, elementary mechanics, mechanical drawing, link motion and valve gears.

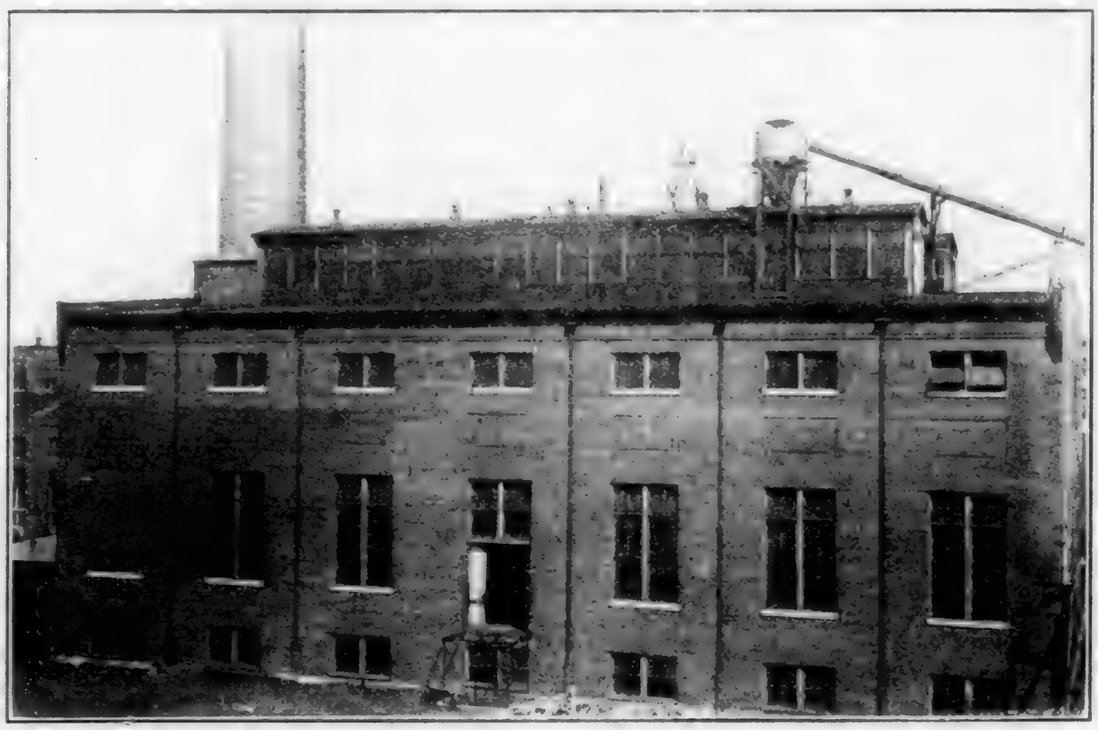
SOUTH LOUISVILLE SHOPS.

Louisville & Nashville Railroad.

III.

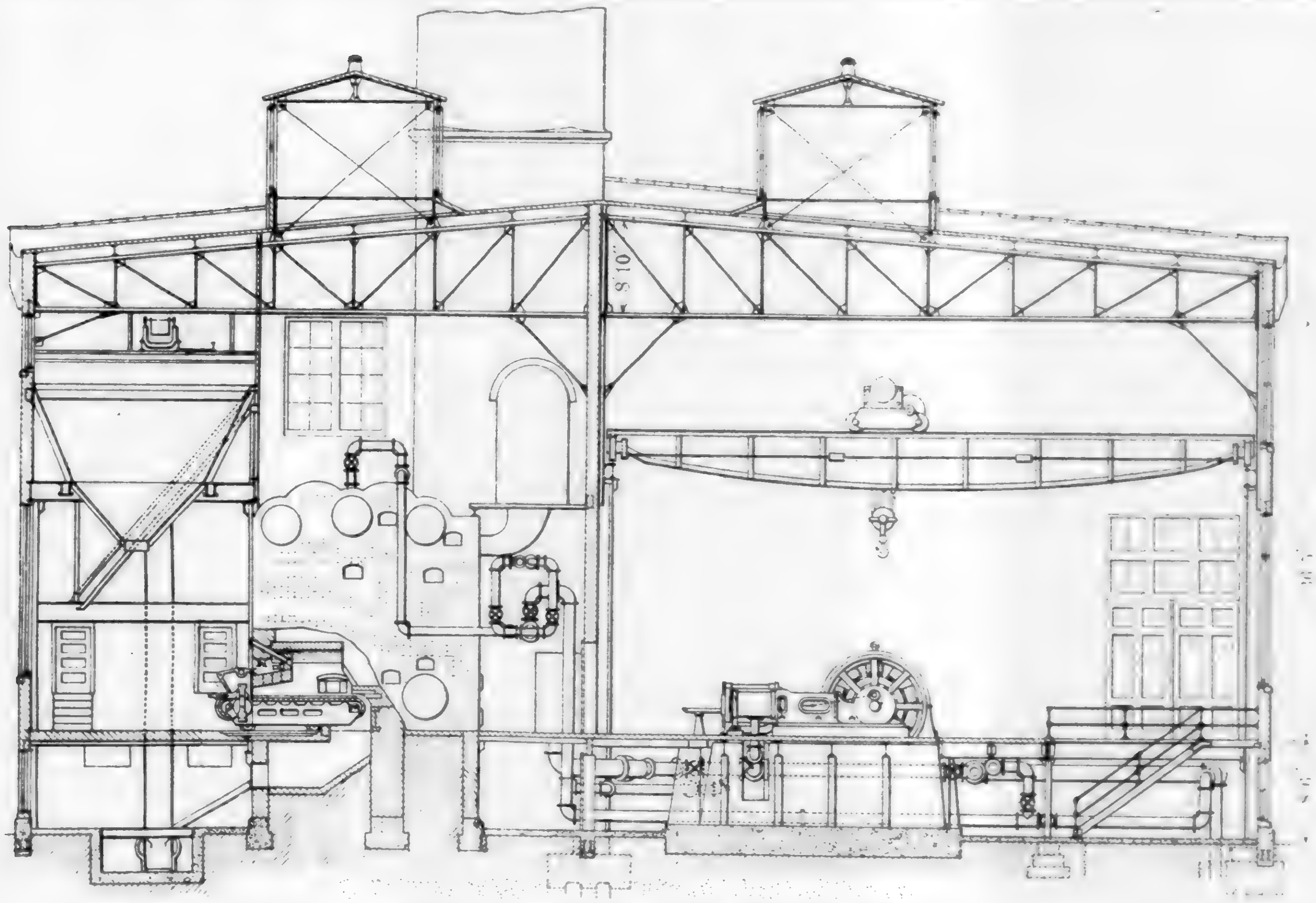
POWER HOUSE.

The power house, while it is apparently located a considerable distance south of the center of gravity of the power distribution, is not as far from it as would appear, since the amount of power required to operate the machines and the shaving exhaust system in the planing mill is quite large compared to that used in any of the other shops, not excepting the locomotive shop. Condensors were not installed, as practically all of the exhaust steam is used by the heating system and in the dry kiln. The piping is very carefully arranged to take care of any emergency and prevent a shutdown in case of accident.



POWER HOUSE—VIEW FROM TOP OF LUMBER SHED.

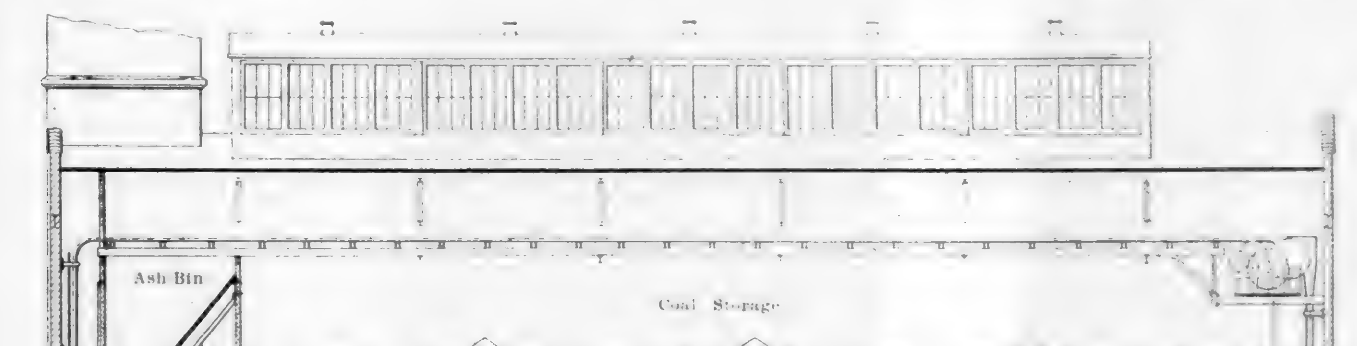
Building.—The power house is a steel frame brick building, 110 ft. by 141 ft. 4 ins., divided by a 13-in. brick wall into a boiler room 48 ft. 8 ins. by 139 ft. 2 ins. and an engine room 58 ft. 1 in. by 139 ft. 2 ins. Over each room is a monitor 7 ft. 10 ins. high and about 15 ft. wide, extending almost



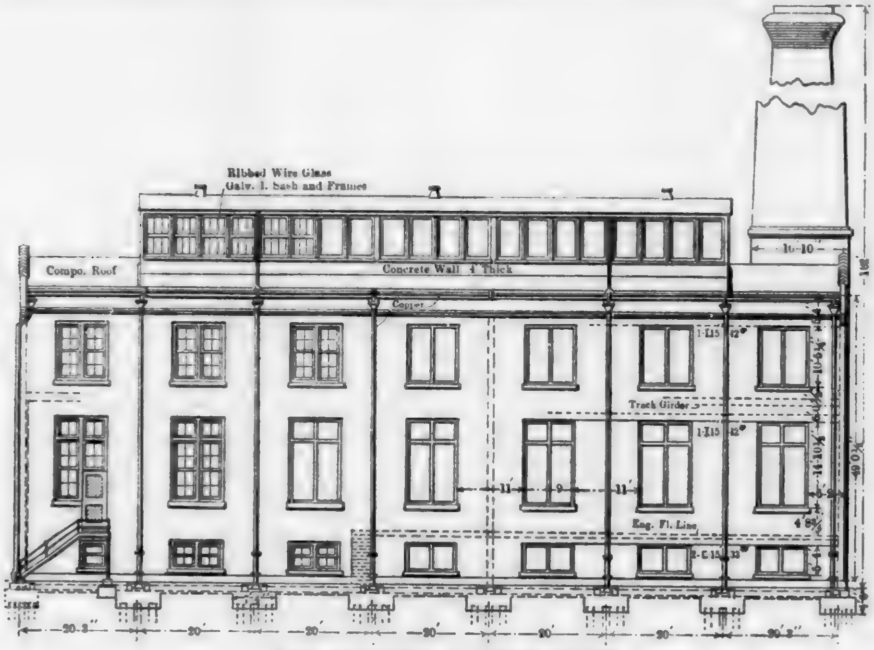
CROSS-SECTION THROUGH ENGINE AND BOILER ROOM.

the entire length of the building. The engine room floor is 8 ft. 10½ ins. above grade and the height from the floor to the underside of the roof trusses is 36 ft. 5 ins. The engine room is equipped with a 5-ton traveling crane (56-ft. span), operated by hand, the runways of which are supported by columns independent of those of the building. The roof purlins consist of 10-in 25-lb. I beams, the wall and ridge purlins of 10-in. 15-lb. channels and the rafters of 2¼ by 2¼ 4.9-lb. T's. A composition roofing is used.

The floor is of concrete, supported by 15-in. I beams, which are in turn supported by cast-iron columns and, wherever possible, by the machinery foundations. The floor of the basement is slightly above grade and consists of concrete laid on a bed of cinders. The basement is lighted by a number of small windows. The window sills are of concrete, and all wood in connection with the windows and doors is covered with galvanized iron, thus making it fireproof. The wainscoting of the engine room is 9 ft. high and of brown pressed



LONGITUDINAL SECTION THROUGH THE BOILER ROOM.



SIDE ELEVATION OF POWER HOUSE.

brick laid in black mortar, except the first four courses just above the floor and two at the top, which are of black brick. The remaining part of the wall is of yellow pressed brick. The coal storage bins and the conveying machinery are supported by a special steel construction.

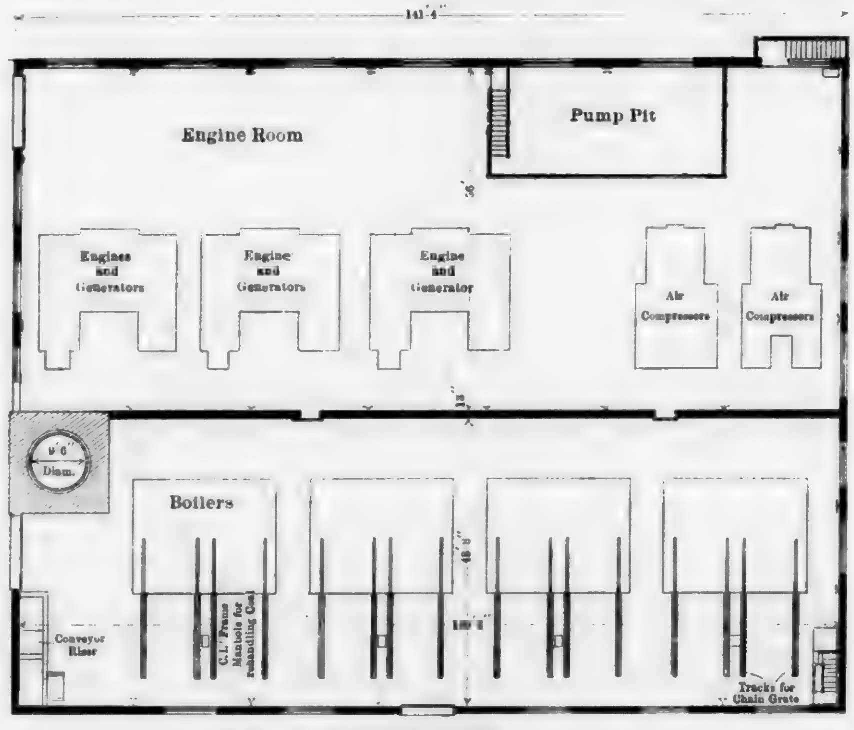
Boilers and Stokers.—There are eight Sterling stokers, each of 305 h.p.; six are equipped with Green chain grate stokers, and two of these, as well as the remaining two of the eight, are arranged for burning the sawdust and shavings from the planing mill, the shavings being fed directly upon the grate through a pair of 6x12-in. spouts, which enter the furnace just above the rear of the igniting arch. The shavings are forced from the galvanized iron storage pockets on the roof of the planing mill by means of a blower system. Power for operating the stokers is furnished by a 6-h.p. Kriebel oscillating engine. Each stoker has an active grate area of 67.5 sq. ft., and is designed to burn bituminous slack. The ashes are raked from the pits into chutes, which deposit them in the conveyor. The concrete slab which partially covers over the top of the ash pit catches the unconsumed coal which drops through the grates, and is also used in connection with a brick damper to shut off the cold air at the back of the grate.

Just outside of the boiler room door at the south side of the building is an elevator, as shown on one of the photographs, by which wood from ends of timber from the planing mill, or other material, may be raised from the ground level to the level of the boiler room floor. It is operated by hydraulic power.

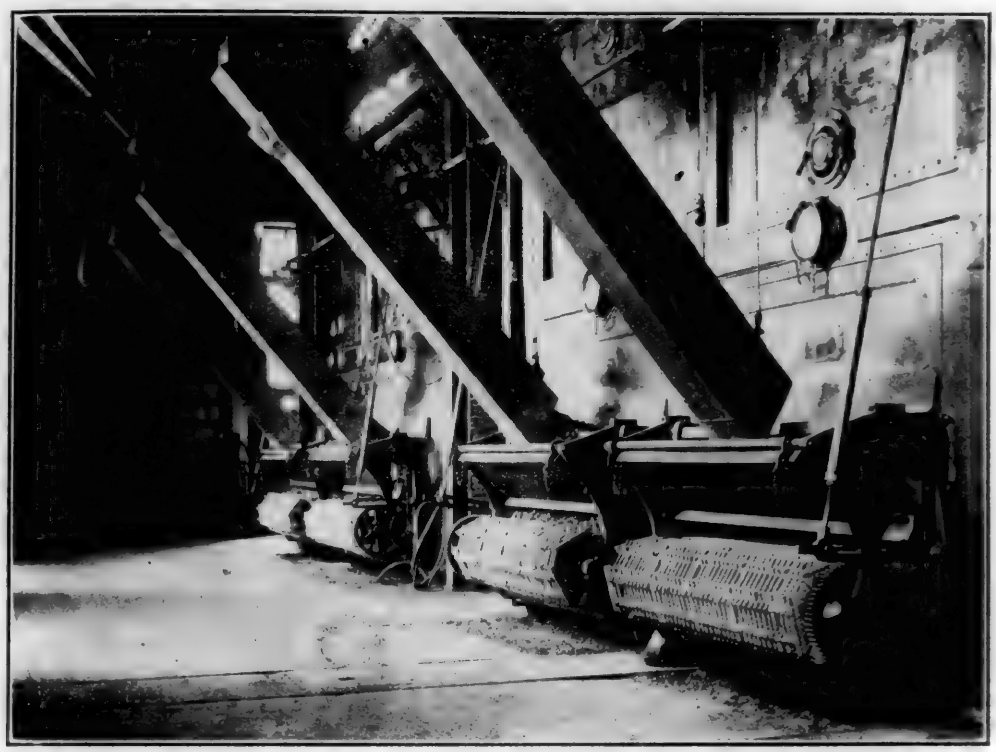
Chimney.—The chimney is 182 ft. high, with a flue 9 ft. 6 ins. in diameter. For a height of 60 ft. the wall is 40 ins. thick, and the cross-section of the chimney is square; above this the cross-section becomes circular. The wall is built in sections 16 ft. 5 ins. in length. The thickness of the wall of each succeeding section is made smaller, until for the top section it is only 8⅝ ins. thick. The chimney is topped with a cast iron cap. It has a fire brick lining carried on bracket projections, making it possible to renew any section of the lining without disturbing the rest, and allowing for expansion in the various parts. It was built by the Alphons-Custodis Chimney Company of New York, of perforated radial bricks, made from a specially selected clay, burned in a high temperature, to render them dense and impervious to moisture. Opposite the opening for the flue is a balance opening of the same shape and size in order that the settlement on the two sides will be equal, and therefore prevent cracking or canting over of the chimney. The balance opening is closed on the outside by a dummy wall.

Coal and Ash Conveyor.—The coal is fed to the stokers from overhead storage pockets of steel and concrete construction, which have a capacity of 1,000 tons, or sufficient to operate the plant for at least three weeks. The coal is delivered to the power house over the track extending along the western side of the building. It is shoveled from the cars into curved chutes, which conduct it to a crusher and feeding device, after which it passes into the conveyor. The coal crusher is operated by a 20-h.p. General Electric motor. The conveyor is of the Peck overlapping pivoted pocket type, was installed by the Link Belt Machinery Company of Chicago, and travels at the rate of 40 ft. per minute, delivering 40 tons of coal per hour. The ashes are conveyed to an overhead ash bin, which, when filled, may be loaded by gravity directly into gondola or hopper cars placed on the track alongside of the building.

Boiler Feed Water.—In one corner of the boiler room is a receiver tank for returns from the steam piping and warm water from every source. Just outside of the boiler house is located a hot well, which takes the discharge of the cooling water from the air compressors. A Reilly pump is used to supply the receiving tank with water from this hot well to make good leakage or waste from the system. Water flows from the receiver tank into a Cochrane feed water heater by gravity, and is drawn from this by two Laidlaw-Dunn-Gordon boiler feed pumps, 16 and 8x10 ins. of the duplex, outside packed, plunger pattern. Between the feed pump section and the feed water heater is placed a reservoir tank in order to furnish a supply on which the boiler feed pumps



PLAN OF POWER HOUSE.



BOILER ROOM SHOWING ARRANGEMENT OF STOKERS.

may draw in case of an emergency. The feed water heater is of 2,000-h.p. capacity, and while it is large enough for ordinary conditions it is sometimes emptied under extraordinary demands, and it is for this reason that the reservoir is placed between the heater and the pump. The reservoir tank is 4 ft. in diameter and 10 ft. high. To regulate the action of the feed water pumps and insure the maintaining of the water line in the boilers at a constant level two Vigilant feed water regulators, manufactured by the Chaplin-Fulton Manufacturing Company of Pittsburgh, have been installed.

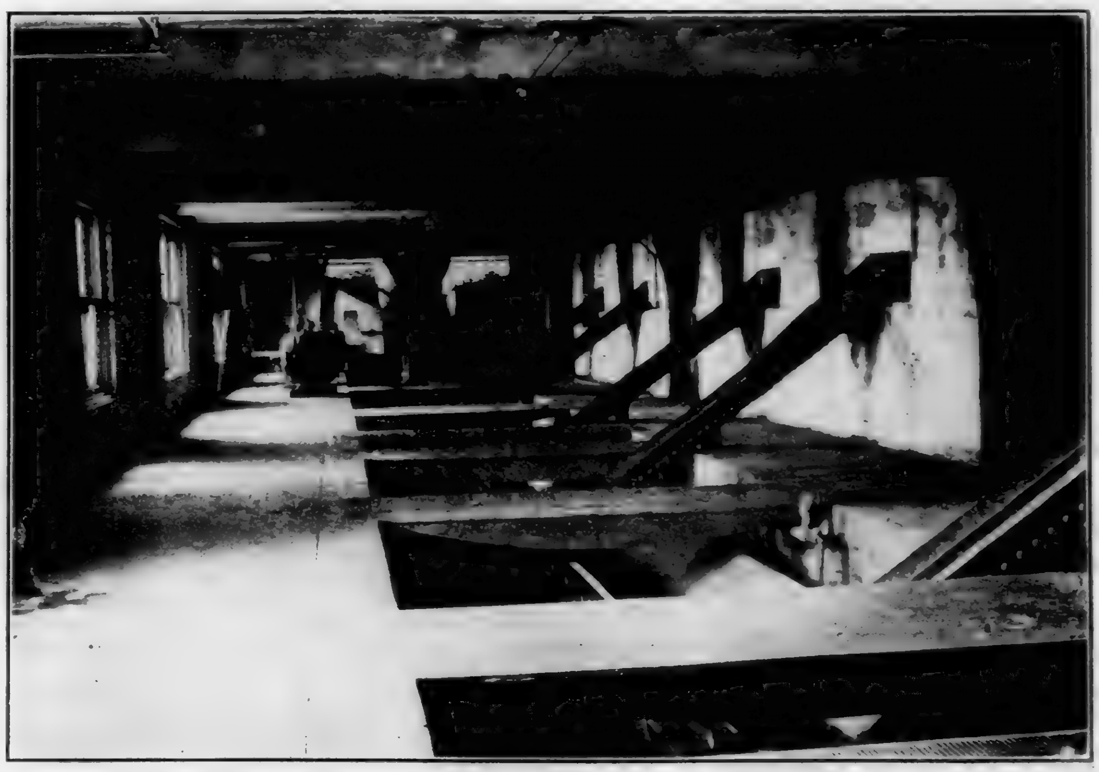
Piping.—The piping for the engines and compressors passes directly through the floor into the basement, and the engine room with no overhead piping thus presents a rather unique appearance. At the rear of the boilers is the main steam header (12 ins.), divided into two sections. Each main header is connected in parallel with a 6-in. auxiliary line, and the two main headers are also connected by a 6-in. line, while the two inner batteries of boilers are connected by an 8-in. line. The use of the large and small parallel mains takes care of the expansion strains, and allows the use of smaller pipe than would otherwise be necessary. This system of piping will take care of almost any emergency, and it also keeps all of the piping warm and avoids the necessity of having to cut cold headers into the system and the consequent trouble due to condensation in the pipes. A 10-in. steam main furnishes live steam for the shops. There are no slip joints in any line of piping.

Engines and Generators.—There are three Buckeye cross compound 18¾ and 32½x12-in. engines, each direct connected to a Bullock type I 350-k.w. generator, furnishing 1,400 amperes at from 240 to 250 volts. An interesting feature in connection with the generators is the brush oscillating device. The brushes are carried on the usual ring rigging placed in bearing wheels, which are revolved slowly, and are forced along their axes until they have moved about ½ in., when they are released and returned to their former place by a spring. By continually repeating this process the brushes are prevented from wearing grooves in the commutator.

Air Compressors.—Two Ingersoll-Sergeant air compressors of the two-stage type, and having cylinders 18 and 24x21 ins., are provided. They each have a capacity of 1,400 cu. ft. of free air per minute. Air is supplied to the shops at 100 lbs. pressure, and no reservoir or receivers are used for the compressed air, as the volume of the 10-in. pipe (1,000 ft. long) conveying the air to the different shops is sufficient to steady all pulsations and provide what storage space is needed.

Pumps.—The service, fire and high-pressure pumps are located in the basement, but the engine room floor is cut away above them, as shown on one of the illustrations.

A Laidlaw-Dunn-Gordon pump, with 12 and 18½x18-in. steam cylinders and 12-in. water cylinders, is used as a service pump for supplying water for the entire plant. It is of the duplex compound type, with steam cylinders in tandem, and controlled by a Fisher governor.



BASEMENT OF BOILER ROOM SHOWING COAL AND ASH CONVEYER.

SIDE ELEVATION OF POWER HOUSE.

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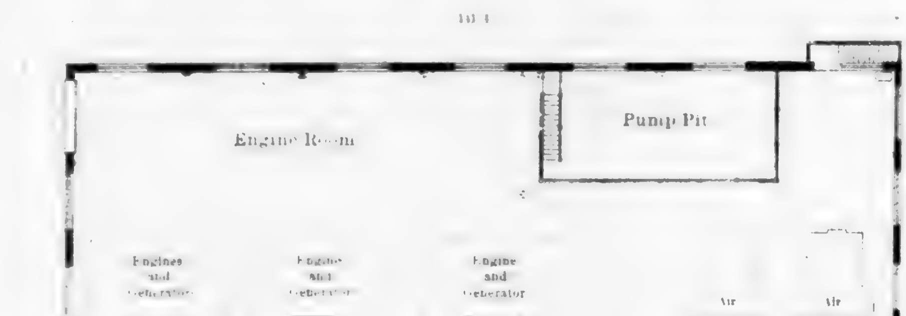

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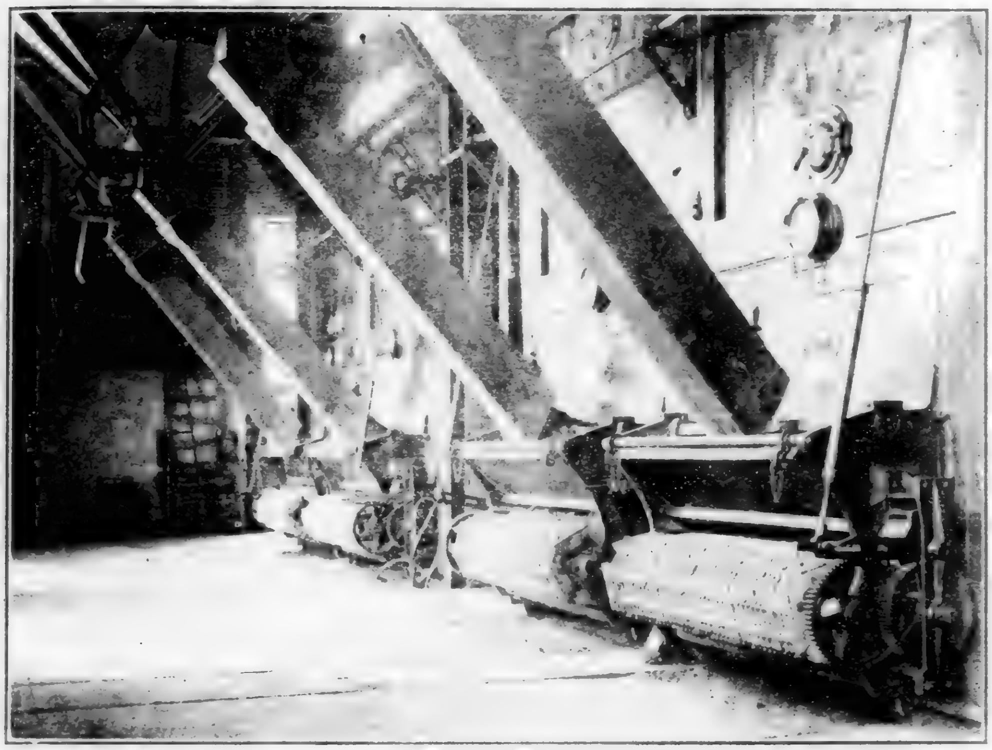

BOILER ROOM SHOWING ARRANGEMENT OF STOKERS.

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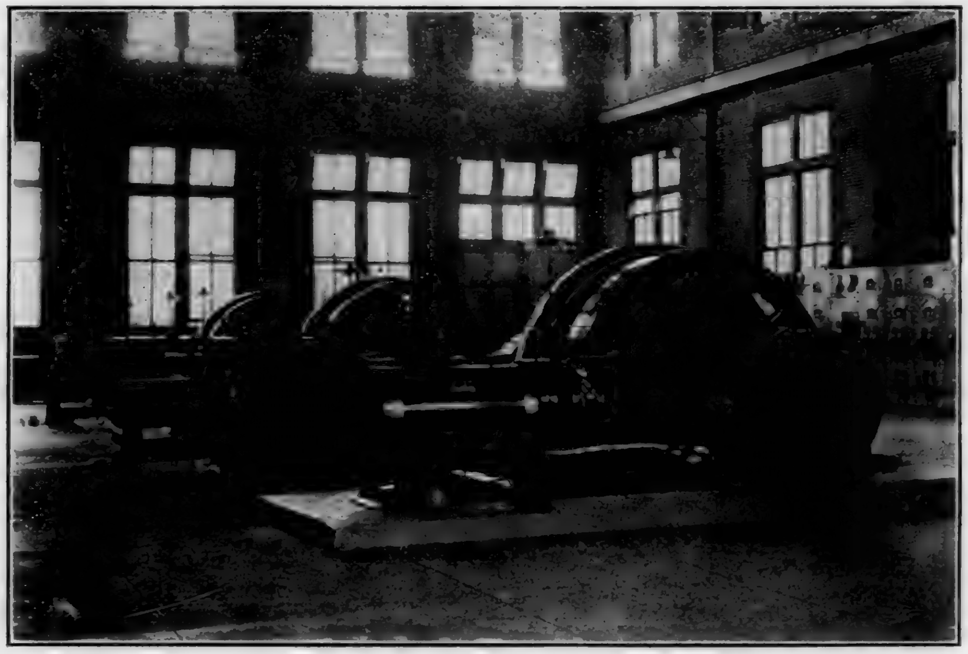
[illegible] OF BOILER ROOM SHOWING COAL AND ASH CONVEYER.



ENGINES AND GENERATORS.

The fire pump is of the Laidlaw-Dunn-Gordon make of the simple duplex type, and has 18 and 10x12-in. cylinders, with a capacity for half a million gallons per hour. The exhaust of this pump is open to the atmosphere.

A Snow pump for furnishing pressure for the hydraulic riveters has 20 and 4x12-in. cylinders, and furnishes 1,500 lbs. pressure. The accumulator is in the boiler shop.

There are also two Marsh vacuum pumps for pumping the water from the return mains of the heating system.

Switchboard.—The switchboard was built by the Western Electric Company to plans prepared by Mr. Ward Barnum, electrical engineer of the railroad. It consists of nine panels of red Tennessee marble, each 30 ins. wide, except the bus bar tie panel, which is 36 ins. wide. The three generator panels are at the left, each having at the top a double pole circuit breaker, below which is a 2,500-amp. ammeter, a rheostat handle and a double throw switch. At the left of the switchboard are two swinging voltmeters for use in throwing in a generator. To the right of the generator panels are two instruments panels; the first has two totalizing ammeters, one for light and the other for power, voltmeter switches for connecting the two swinging-arm voltmeters, and, at the bottom, tie switches for throwing the lights either on high or low bus bars, as may be desired. The second instrument panel has two recording voltmeters, a 4,000-ampere integrating watt-meter for power circuits and a 2,000-ampere instrument for the lighting circuits. The ground detecting devices are placed upon this totalizing panel. These consist of an instrument switch, one for each bus, arranged so that readings across the bus bars and from either bus to ground are made on the station voltmeter mounted at the end of the switchboard. On the right hand end of the board are four feeder panels, each of which contains a 2,000-ampere ammeter for power, a 600-ampere ammeter for lights and the circuit breakers, which act also as switches for power and light feeders.

IMPROVEMENTS TO THE SUEZ CANAL now under way include an increase of depth throughout to 31 ft. and the bottom width to 128 ft., which will permit an increase of speed of vessels passing through it from six to nine miles per hour. This will enable ships to make the passage through the canal in 12 hours, about 6 hours less than at present.—*The Engineering Record.*

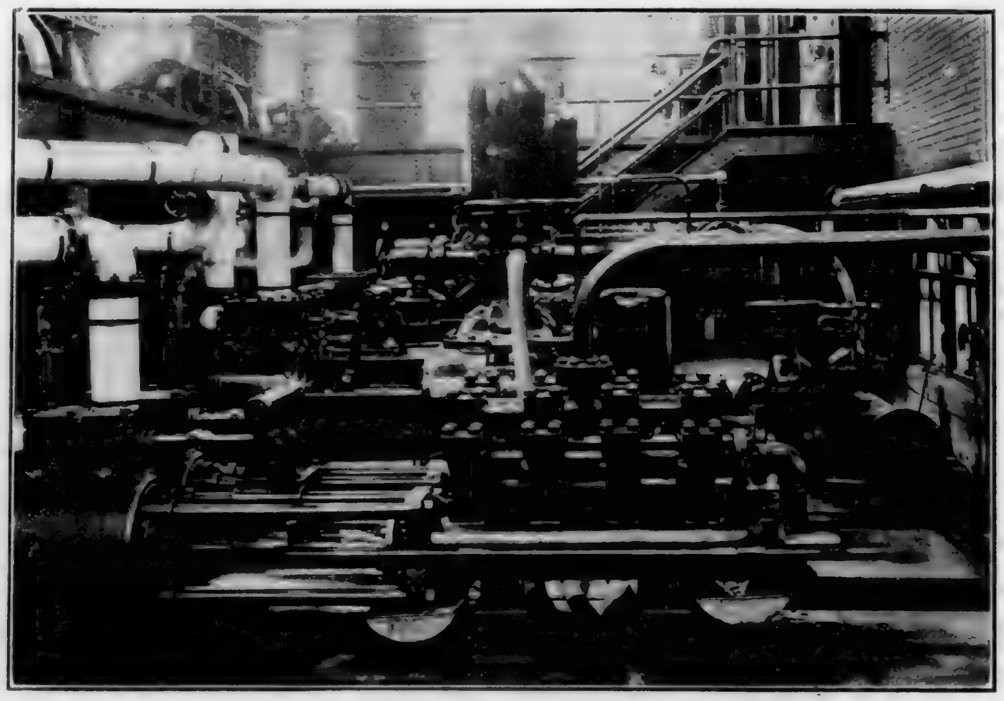
CAR FERRIES.—There are now thirty-five companies operating car ferries in North America, and they cover 1,360 miles of territory. Nine years ago there were only 197 vessels in service, with an aggregate capacity of 2,069 cars; now there are 562 boats, with a capacity of 5,615 cars. The average number of cars carried daily by all lines is about 11,500.

CHECKING INTAKE AND OUTPUT OF MATERIAL DELIVERED TO SHOPS.*

BY J. H. CALLAGHAN.

The Angus shops of the Canadian Pacific Railway, located at Montreal, are the largest group of railway shops on the continent, covering as they do an area of 250 acres, with 17 acres under roof, and consisting of the following shops: Locomotive erecting and machine shop, gray iron foundry, wheel

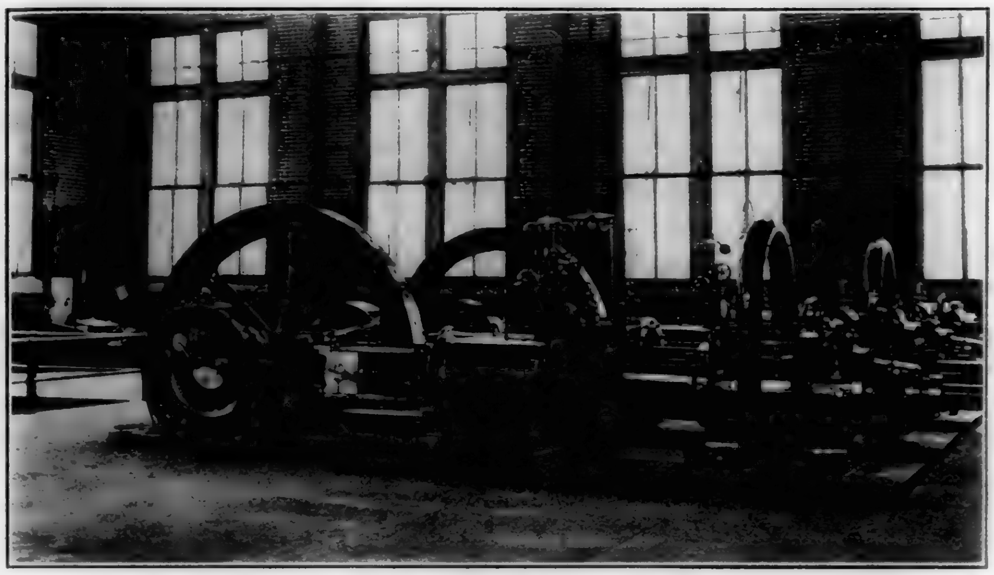
*Abstract of a paper presented at the recent convention of the Railway Storekeepers' Association. The part referring to the wheel foundry, the frog and switch shop, paint and lumber, has been omitted. The Angus shops were described in the AMERICAN ENGINEER AND RAILROAD JOURNAL as follows: General arrangement, December, 1904, page 451; buildings, January, 1905, page 1; and Feburary, 1905, page 37; power plant, March, 1905, page 75; truck shop, car machine shop, freight car erecting shop planing mill and passenger car shops, April, 1905, page 114; locomotive shop, May, 1905, page 161, and June, 1905, page 219; foundries, September, 1905, page 326; blacksmith shop, October, 1905, page 363.



HIGH PRESSURE, SERVICE AND FIRE PUMPS.

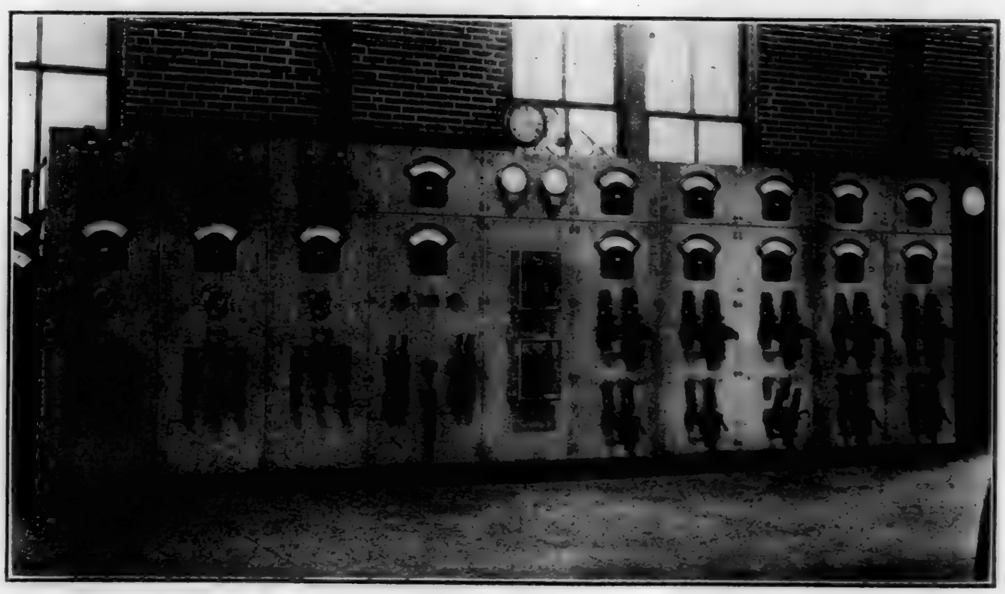
foundry, frog and switch shop, blacksmith shop, car machine shop, car truck shop, freight car erecting shop, planing mill, cabinet shop, upholstering shop, passenger car erecting and paint shop, passenger car repair shop. In order to allow of my giving an accurate idea of the system of shop requisitions and store orders in use, covering the intake and output of material supplied to and delivered from the various shops, I will treat each unit separately.

Locomotice Erecting and Machine Shop.—In this shop new locomotives are built, engines are repaired and locomotive parts, coach trimmings, water tank parts, roundhouse drop jacks, etc., are manufactured and delivered to the stores department for shipment to the various points on the entire system. To meet the ever-increasing demands for material to keep this shop moving I have no less than four petty stores in and about it, namely, petty general store, located in center of building; petty paint store, located near tender and cab section in shop; also stock of steel plates, angles, tees, tires, bolsters, wheels, etc., located outside west end of shop contiguous to boiler shop section and stock of boiler tubes, dry pipes, superheating pipes, etc., located outside of building, but immediately adjacent to tube furnaces and steam fitters' section. All of these stores are under charge of storemen, and the business transacted in connection with them is carried on in precisely the same manner as if the deliveries to the shop were made from the general store building. Stock books are carried in each of them, together with day books, into which a correct record of all receipts and disbursements are posted, which at the end of each month are summarized and posted into stock book before the same is turned into the general store to allow of correct compiling of the regular monthly requisitions on the general purchasing agent. The forms of shop requisitions known and variously described as shop requisition form M and shin plaster are in general use throughout the plant, so also is the form covering goods drawn for manufactured material. This form is made out and signed by the several foremen who are authorized to issue them and are given to the storemen, who supply the material. These forms are then priced and classification item and class number added to them, after which record is taken of them, and at the close of the day's business they are turned into the general store, to be included with the various other lots received from all other petty stores on the plant, and sent into the office the following morning, together with the forms covering disbursements from the general store to be posted or, rather, charged to the various accounts for which the material was required. These forms are made in duplicate, the foreman issuing them retains the duplicate, while the original is delivered to the storeman. Eventually, however, both original and duplicate find their way to the office and are there compared, one being a check against the other, so that you not only have the store form, covering the material issued, but the mechanical department's acknowledgment of its receipt. In this shop we have a group of three general disbursing accounts, namely, "repairs," which, of course, gives reference to engine numbers, steam shovels, rotary plows, etc.; "new rolling stock," which gives the equipment order numbers, and "manufactured material," covering the numerous store orders placed on the shop. Under these headings the intake of material and the output of work is checked up, posted, and cost arrived at. This is the system in general use and is a clear and simple method, and, if properly conducted by all interested, offers a very accurate solution of the cost problem. While I say this is the system in general use, there are exceptions brought about by the impracticability of applying it in conducting the department's business in connection with some of the shops, and it is for this reason I wish to treat each of the shops where such differences occur and which go to make up the whole, separately.

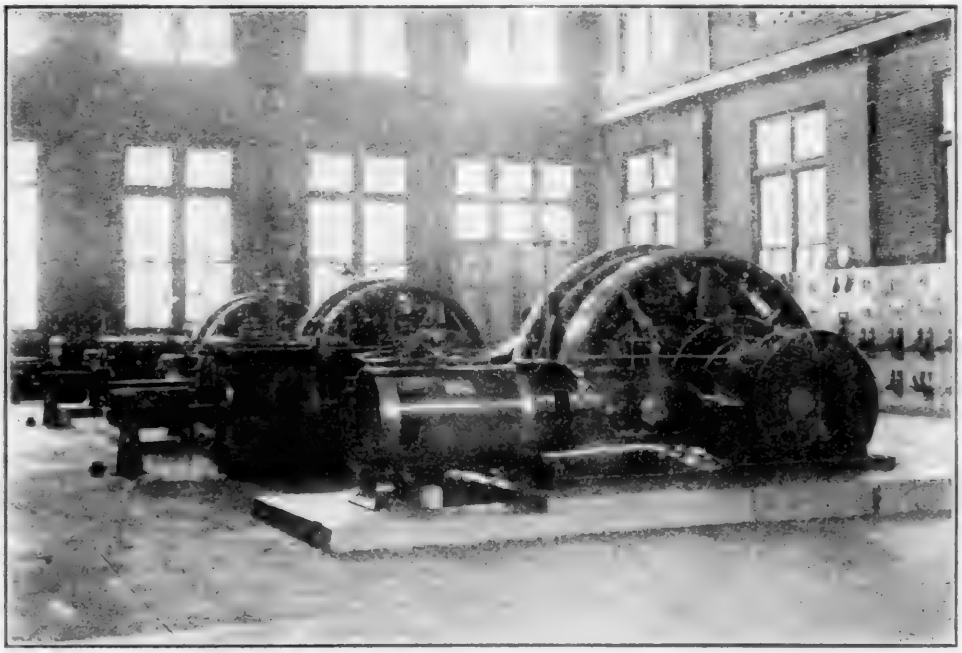


GENERAL VIEW OF AIR COMPRESSORS.

Foundries.—From our two foundries, grey iron and wheel, we turn out the majority of grey iron castings for the entire system and the total wheel supply for the road. Similar general accounts, namely, repairs and equipment, are handled here on the same lines as in the other shops, with the exception that all requisitions covering such accounts are merged into store orders and placed o nthe foundry by storeman in charge. To make this condition plain I will endeavor to give you an



MAIN SWITCH BOARD IN ENGINE ROOM.



ENGINES AND GENERATORS.

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A Snow pump for furnishing pressure for the hydraulic riveters has 20 and 4x12-in. cylinders, and furnishes 1,500 lbs. pressure. The accumulator is in the boiler shop.

There are also two Marsh vacuum pumps for pumping the water from the return mains of the heating system.

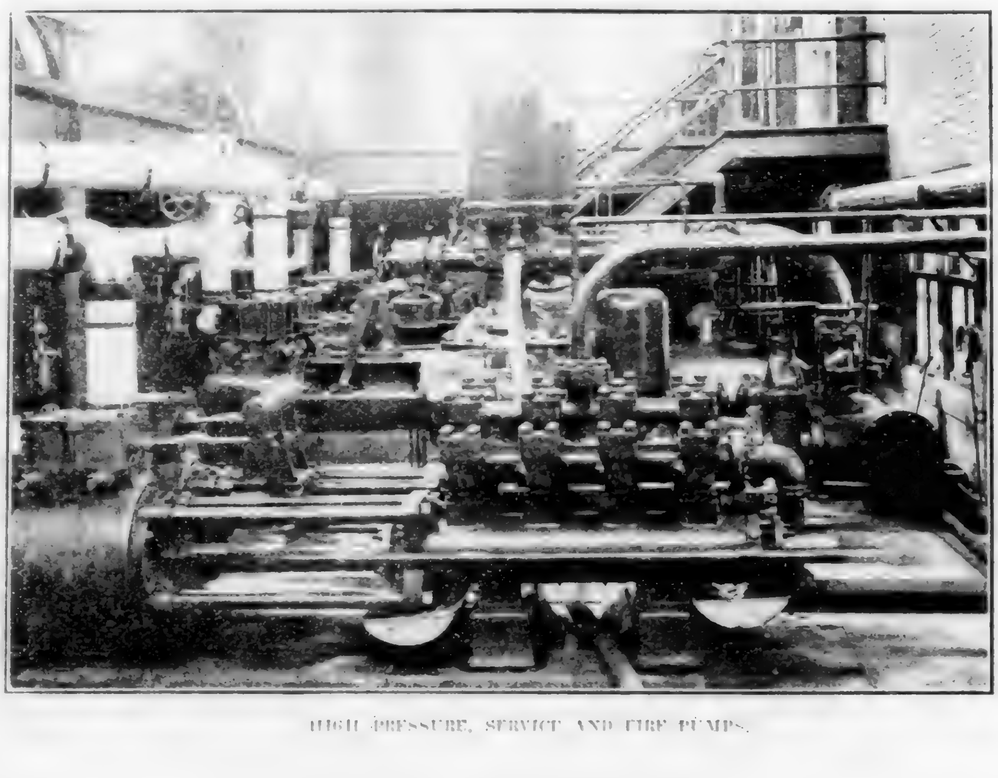
Switchboard.—The switchboard was built by the Western Electric Company to plans prepared by Mr. Ward Barnum, electrical engineer of the railroad. It consists of nine panels of red Tennessee marble, each 30 ins. wide, except the bus bar tie panel, which is 36 ins. wide. The three generator panels are at the left, each having at the top a double pole circuit breaker, below which is a 2,500-amp. ammeter, a rheostat handle and a double throw switch. At the left of the switchboard are two swinging voltmeters for use in throwing in a generator. To the right of the generator panels are two instruments panels; the first has two totalizing ammeters, one for light and the other for power, voltmeter switches for connecting the two swinging-arm voltmeters, and, at the bottom, tie switches for throwing the light either on high or low bus bars, as may be desired. The second instrument panel has two recording voltmeters, a 1,000-ampere integrating watt-meter for power circuits and a 2,000-ampere instrument for the lighting circuits. The ground detecting devices are placed upon this totalizing panel. These consist of an instrument switch, one for each bus, arranged so that readings across the bus bars and from either bus to ground are made on the station voltmeter mounted at the end of the switchboard. On the right hand end of the board are four feeder panels, each of

CHECKING INTAKE AND OUTPUT OF MATERIAL DELIVERED TO SHOPS.*

BY J. H. CALLAGHAN.

The Angus shops of the Canadian Pacific Railway, located at Montreal, are the largest group of railway shops on the continent, covering as they do an area of 250 acres, with 17 acres under roof, and consisting of the following shops: Locomotive erecting and machine shop, gray iron foundry, wheel

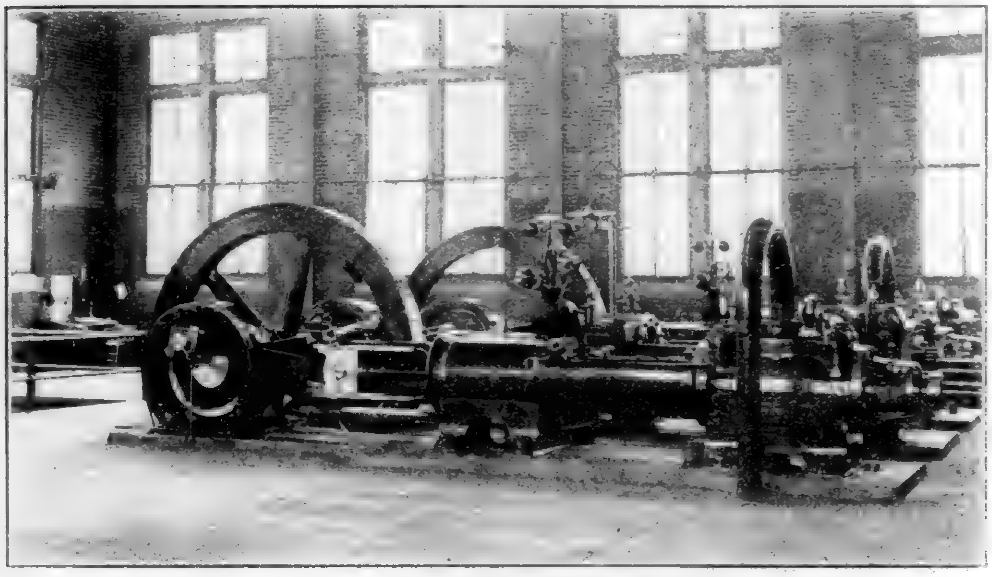
*Abstract of a paper presented at the recent convention of the Railway Storekeepers' Association. The part referring to the wheel foundry, the frog and switch shop, paint and lumber, has been omitted. The Angus shops were described in the AMERICAN ENGINEER AND RAILROAD JOURNAL as follows: General arrangement, December, 1904, page 451; buildings, January, 1905, page 1; and Feburary, 1905, page 37; power plant, March, 1905, page 75; truck shop, car machine shop, freight car erecting shop planing mill and passenger car shops April, 1905, page 114; locomotive shop, May, 1905, page 161, and June, 1905, page 219; foundries, September, 1905, page 326; blacksmith shop, October, 1905, page 363.



HIGH PRESSURE, SERVICE AND FIRE PUMPS.

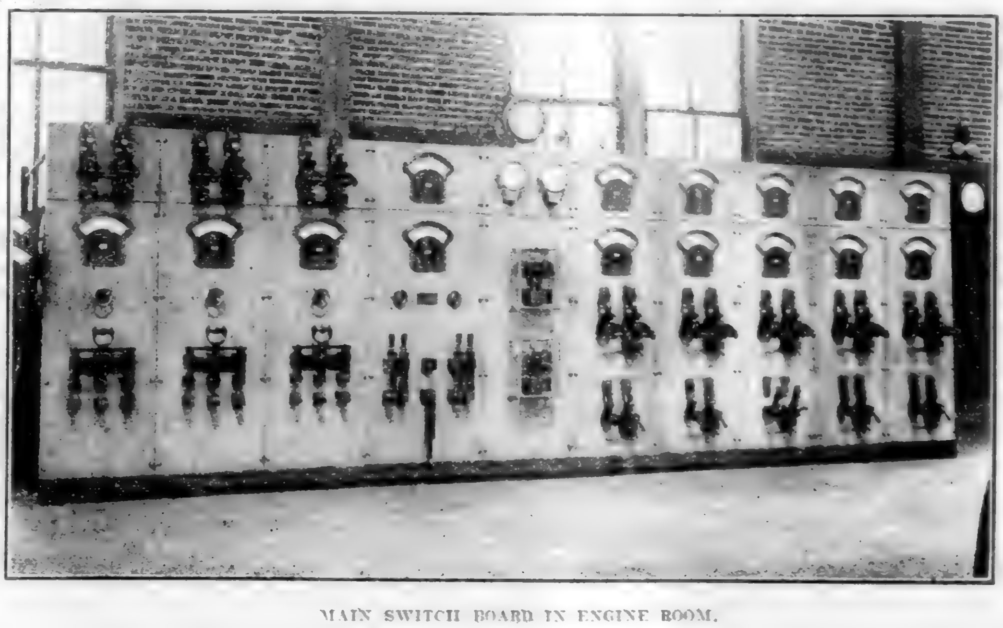
foundry, frog and switch shop, blacksmith shop, car machine shop, car truck shop, freight car erecting shop, planing mill, cabinet shop, upholstering shop, passenger car erecting and paint shop, passenger car repair shop. In order to allow of my giving an accurate idea of the system of shop requisitions and store orders in use, covering the intake and output of material supplied to and delivered from the various shops, I will treat each unit separately.

Locomotive Erecting and Machine Shop.—In this shop new locomotives are built, engines are repaired and locomotive parts, coach trimmings, water tank parts, roundhouse drop jacks, etc., are manufactured and delivered to the stores department for shipment to the various points on the entire system. To meet the ever-increasing demands for material to keep this shop moving I have no less than four petty stores in and about it, namely, petty general store, located in center of building; petty paint store, located near tender and cab section in shop; also stock of steel plates, angles, tees, tires, bolsters, wheels, etc., located outside west end of shop contiguous to boiler shop section and stock of boiler tubes, dry pipes, superheating pipes, etc., located outside of building, but immediately adjacent to tube furnaces and steam fitters' section. All of these stores are under charge of storemen, and the business transacted in connection with them is carried on in precisely the same manner as if the deliveries to the shop were made from the general store building. Stock books are carried in each of them, together with day books, into which a correct record of all receipts and disbursements are posted, which at the end of each month are summarized and posted into stock book before the same is turned into the general store to allow of correct compiling of the regular monthly requisitions on the general purchasing agent. The forms of shop requisitions known and variously described as shop requisition form M and shin plaster are in general use throughout the plant, so also is the form covering goods drawn for manufactured material. This form is made out and signed by the several foremen who are authorized to issue them and are given to the storemen, who supply the material. These forms are then priced and classification item and class number added to them, after which record is taken of them, and at the close of the day's business they are turned into the general store, to be included with the various other lots received from all other petty stores on the plant, and sent into the office the following morning, together with the forms covering disbursements from the general store to be posted or, rather, charged to the various accounts for which the material was required. These forms are made in duplicate, the foreman issuing them retains the duplicate, while the original is delivered to the storeman. Eventually, however, both original and duplicate find their way to the office and are there compared, one being a check against the other, so that you not only have the store form, covering the material issued, but the mechanical department's acknowledgment of its receipt. In this shop we have a group of three general disbursing accounts, namely, "repairs," which, of course, gives reference to engine numbers, steam shovels, rotal plows, etc.; "new rolling stock," which gives the equipment order numbers, and "manufactured material," covering the numerous store orders placed on the shop. Under these headings the intake of material and the output of work is checked up, posted, and cost arrived at. This is the system in general use and is a clear and simple method, and, if properly conducted by all interested, offers a very accurate solution of the cost problem. While I say this is the system in general use, there are exceptions brought about by the impracticability of applying it in conducting the department's business in connection with some of the shops, and it is for this reason I wish to treat each of the shops where such differences occur and which go to make up the whole, separately.



GENERAL VIEW OF AIR COMPRESSORS.

Foundries.—From our two foundries, grey iron and wheel, we turn out the majority of grey iron castings for the entire system and the total wheel supply for the road. Similar general accounts, namely, repairs and equipment, are handled here on the same lines as in the other shops, with the exception that all requisitions covering such accounts are merged into store orders and placed o nthe foundry by storeman in charge. To make this condition plain I will endeavor to give you an



MAIN SWITCH BOARD IN ENGINE ROOM.

outline covering the conditions under which our foundries are conducted. First of all, we aim at treating them on the lines we would an outside concern, so that we may exact from them the same (though we figure on better) service we would from outside foundries. They are operated by the car department, and the master car builder is directly responsible for their operation and output. At the same time the total intake of raw material and the output of finished castings are the property of the general storekeeper, hence the importance of checking and weighing the intake and output by store department employes. To take care of this work there are two foundry checkers and one foundry clerk, whose offices are located in the scale room, through which all material must pass on its way to the cupolas, so that nothing goes into the cupolas without first crossing the scales and being correctly weighed by my foundry clerk. These weights are posted in a book kept for the purpose and are final; no forms are given covering this material, which consists of pig iron of various brands, broken wheels, scrap, coke, manganese, etc. The same is true of the various materials used in the foundries proper, such as sands, facings, flour, etc.; in short, all material required for the operation of these foundries is supplied without the usual shop form M already referred to as applying in the locomotive, erecting and machine shop, so that the total cost covering intake of these foundries is made up from foundry clerk's scale and material issued records.

The output, allowing for shrinkages, is always a check on the intake, but, so that a correct record is arrived at, all castings made in the grey iron foundry when cleaned and ready for delivery are checked as to pattern numbers and weighed, and as each load is checked out O. K. on the scale the tally incorporating the various items making up the load is signed by my foundry checker (who retains a copy), and is handed back to the foundry foreman's representative as his authority for delivery. The loads referred to are loads of about two tons; they are usually made up so as to allow their being delivered direct to the various shops for which they were ordered without rehandling after crossing the scales. By this I mean castings for the coach shop would not be included with load for locomotive, freight car or switch shop, and in this way the foreman of the shop receiving the load accepts the check as to contents made by the foundry foreman, and my foundry checker, and delivers to the latter the shop forms M covering the load, which forms show in detail the various accounts to which the different patterns are to be charged. The shop foreman arrives at this information from the tally slip already referred to, which shows the requisition number covering the casting or castings made, taken from my order placed on the foundry. This apparently complex or detailed method of handling the grey iron foundry output is made necessary from the fact that we use this foundry as a petty store in making deliveries to the different shops, it being inadvisable from a business standpoint to deliver the total output to the general store to be rehandled and delivered to the shops. The line shipments, however, are sent from the general stores accompanied with the necessary shipping slips, and are here loaded into cars and forwarded to their several destinations.

Blacksmith Shop.—From this shop the forgings for our total new equipment orders are turned out; also the bulk of car forgings required in the keeping up of repairs of freight and passenger rolling stock. We have here bulldozers and oil furnaces, together with the various other machinery and equipment, to allow of our turning out the iron work for 600 standard box cars per month, together with new coaches and sleepers, while the locomotive side is provided with the necessary equipment to allow of the prompt turning out of new engines and locomotive repairs. These few facts are simply cited to give some idea as to the magnitude of the task attaching to the effort which is necessary to follow anything like the total intake of this shop on the regular lines followed in other shops.

You will note from the location of material about this shop the opportunity offered to get at it without the necessary requisition form. There are not only doors every few yards, but windows, and contract men are not particular as to how they get material to work with; it is simply a matter of "get it" with them; never mind the red tape. Now if we were only building cars from the output of this shop the intake question would be of little concern, but as we are repairing and manufacturing for the line it becomes absolutely essential to have accuracy not only in connection with the intake of this most perplexing problem, but absolute correctness in checking the output. So far as pertains to deliveries from our regular iron rack or house no difficulty is encountered, as the business here is handled in exactly the same manner as if issues were made from the general store.

There is in this building an office with phone communication with all petty stores, offices and shops, together with a good store staff, including proper checkers and stock-keeper. All issues made from this rack are properly covered by the regular shop requisition form M, which is priced, classified and sent through the regular channel as already described. The stock here consists of all brands of iron, from the finest to the ordinary common, all in standard market lengths; tool steel in bewildering varieties all painted or marked for identification, also spring steel, gas pipe and chain, and is used almost exclusively for the filling of line requisitions and repairs in the various shops. The iron house, however, is but a very small part of the iron problem at our works, so much so that further remarks by me in connection with it are unnecessary; it is thoroughly organized and can take care of itself.

Now to get at the greater field of iron deliveries: Your attention is called to the general lay-out of the stock. In the average standard 30-ton box car we have about 5,200 lbs. of wrought iron or mild steel, in a standard coach or diner about 23,000 lbs. We have orders on the shops at present for thousands of the former and something like a hundred of the latter. This will give you a fair idea of the amount of stock we must carry for these purposes. In ordering iron for new rolling stock we make it a practice of ordering iron cut to length for various purposes required; that is, in ordering arch bar iron instead of calling for standard bars we get pieces. The same applies to all other forgings to allow of the various sizes and kinds of iron being piled together, always keeping in mind the necessity of locating these piles convenient to the various machines through which they must pass; that is, truss rods near the upsetting and screwing machines, carry irons near the bulldozers, and so on. You will at once recognize the difficulties one must expect to meet in endeavoring to check in the requirements of this shop.

The argument has been advanced that every pound of iron entering a smith shop should be weighed in, and the finished product as it goes out should undergo the same ordeal; this so that some statistical fiend might arrive at the actual waste in scalings, turnings, borings, etc. This proposition sounds all right, and might work very nicely at a small shop, where they use about a ton or two of iron a day, but in a plant like ours its introduction would be practically disastrous. Take, for instance, bulldozers with dies all placed waiting for raw stuff to be weighed out piecemeal to them; think of the furnaces in connection with them getting away with fuel oil to the tune of 2,000 to 3,000 gals. per day, the piecework men with their hands tied, and you have some idea of what this method would mean. And then the output: Our company wants all the cars it can get into service, and as quickly as it can get them, to cope with the ever-increasing business which the unprecedented prosperity of the country has made necessary. At our present rate of building we are turning out a car every 20 minutes. Think of what weighing the output would mean to this business alone. I venture to say a reduction in the output of three to four cars per day would be the result. Would it pay or is there not some other way in which the intake and output of this plant can be taken care of which will give the same results without clogging the wheels of progress? Yes, there is, and I will endeavor to out-

line it. Take, for example, an order is placed for 1,000 standard 30-ton box cars; the bill of material incorporating all items entering into the construction of these cars is sent to me by the master car builder. This statement is checked and marked, and all items other than what we manufacture ourselves, such as wheels, castings, etc., are made on a special requisition placed with the general purchasing agent. The original bill of material is then sent to my storeman in charge of business in the freight car erecting shop, and is there posted in a special receiving book, which is kept for the purpose; it is then returned to the general store for filing. When the material starts coming in (you may have material coming in on several orders of freight cars at the same time) it is weighed, checked and compared with the tallies which accompany all shipments, whether they are received in cars or by city teams. When all material is in the lines opposite each item bear a tick mark or O. K. Now when it is decided to start building this order, the number of cars turned out each night is made up by my man and compared with the car foreman's record, and certain material, such as Westinghouse air brake material, roofs, truck bolsters, springs and iron are then covered by an order from the car foreman to my storeman, who posts them in his output book and forwards them to the general store, to be sent along with the disbursements to all other shops, and are delivered to the office to be charged up to the proper equipment account. This same system of getting at the intake and output of the shop applies to new coaches, sleepers, diners and to new engines.

CENTER OF GRAVITY OF A LOCOMOTIVE.—SIMPLE METHOD OF DETERMINING.

BY G. R. HENDERSON.

[We have recently received several requests to present a description of a simple method of determining the center of gravity of a locomotive. The following article is reprinted from page 319 of the October, 1899, issue of this journal and describes a very simple and practical method.]

The determination of the center of gravity of locomotives is a laborious task when computed mathematically, because in order to be accurate the weight and location of the center of gravity of each and every piece should be ascertained and their moments above the rail figured out, but the labor being so great, assumptions are made which affect more or less the final figures. It occurred to the writer that a practical method could be applied, and the following was therefore evolved:

Suppose that we have a body of symmetrical cross section, the weight of which is known. If this body be tipped slightly, so that one of the edges upon which it stands is lower than the other, the center of gravity will be displaced laterally. If this body rests upon supports at the two lower edges only, then the lower support will sustain more weight than the higher one, due to the lateral displacement of the center of gravity, and if the angle is such that the center of gravity be vertically over the lower edge, the total weight will come on this edge, and the body will be in unstable equilibrium. Thus, in Fig. 1, the whole weight will come upon the support B, but in Fig. 2 a portion will rest upon A and another portion upon B, but the sum of these two will be equal to the total weight. Let the weight of a symmetrical body be represented by W, the load on each support by Pa and Pb, respectively; then Pa plus Pb equals W. Let also the horizontal distance between the supports be represented by h and the vertical difference by v; also the distance measured horizontally between the support B and a vertical dropped through the center of gravity be represented by x. Now, by equal moments Pa × h equals W × x and

$$x = \frac{Pa \times h}{W.}$$

As the body is symmetrical, the center of gravity must be in the central axis c-d and at the intersection with the vertical through y, at a distance x from B, or at O. This may be laid off graphically, or it may be calculated by similar triangles.

This principle was practically applied to a locomotive, as follows: The engine was first carefully weighed on the track scales, with a certain height of water, etc., and was backed off the scales. The rail was then removed from the narrow side of the scale platform and blocks laid close together, like ties, from the outer frame to the fixed or dead rail support, care being taken to see that the portion of the scale under these blocks was entirely free. A rail was laid to gauge on these blocks and a slope prepared at one end. All was now ready, and, the beam being balanced, the water was brought to the same level as before in the boiler and the engine run upon the new track, and the load upon the lower rail weighed. While the engine is upon the scales a level should be run from rail to rail to determine the exact difference of level for use in making the calculations. Of course, there is a slight error, due to shifting of the water sidewise in the boiler, which tends to exaggerate the result. The frames should be blocked over the boxes, so that the boiler will stand relatively to the wheels, the same as on level track.

If care be taken, accurate results may be obtained, as with the small elevation of about 7½ ins. an increase in weight of 25,000 lbs. on the lower side of the engine was shown by the

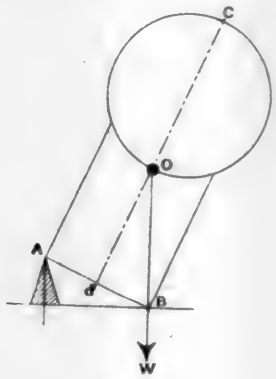


Fig. 1.

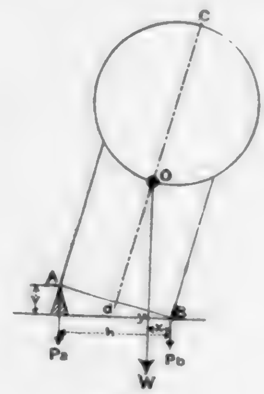


Fig. 2.

scales, the total weight of the locomotive being about 140,000 lbs.

[The following example of an application of the above method is taken from page 19 of Mr. Henderson's book on "Locomotive Operation," published in 1904. With a rail elevation of 7⅝ ins., the scale beams indicated 95,500 lbs. (Pb) on the lower rail and a measure of 58¼ ins. between points of rail contact (A and B) and 29½ ins. from the center line of the engine (c-d) to the lower rail contact. Now, if $W =$ total weight and $Pb =$ that on lower rail, while Pa is that on the higher rail, we must have $W = Pa + Pb$, and $Pa = W - Pb$, or $141{,}000 - 95{,}500 = 45{,}500$ lbs. So, by equating the moments, we find $Pa \times 58\frac{1}{4} = W \times x$, and

$$x = \frac{Pa \times 58\frac{1}{4}}{W} = \frac{45{,}500 \times 58\frac{1}{4}}{141{,}000} = 18.8 \text{ ins.}$$

In order to determine f (distance between the intersection of line c-d and line oW on line A-B) accurately (which is necessary), we must figure $f = 29\frac{1}{2} - 18.8$; sec e, e being the angle of inclination (d o W) from the vertical. But tan

$$e = \frac{7.62}{58.25} = .1325,$$ indicating that angle $e = 7° 33'$, and the secant of 7° 33′, or sec $e = 1.0087$, therefore $f = 29.5 - 1.0087 \times 18.8 = 10.5$ ins., and as $f = h \tan e$, we have

$$h = \frac{f}{\tan e} = \frac{10.5}{.1325} = 79.25 \text{ ins.},$$ which is the height of the center of gravity above the rail.]

SHEET METAL COVERED WINDOWS are finding favor with insurance underwriters, as statistics show that 31 per cent. of the 80,000 buildings consumed by fire in 1905 were ignited by burning buildings adjoining.—*Iron Age.*

THE MATHEMATICAL ANALYSIS OF THE WALSCHAERT VALVE GEAR.

By Edward L. Coster,
Assoc. Am. Soc. M. E.

"The motion of a valve controlled by the Walschaert gear can be represented in a general way by Zeuner's diagrams, but the discrepancy between the results from such diagrams and the actual valve-motion is too large to allow us to use the diagrams even for a preliminary design. The general conception, however, is a very important matter,"[1] and is as follows:

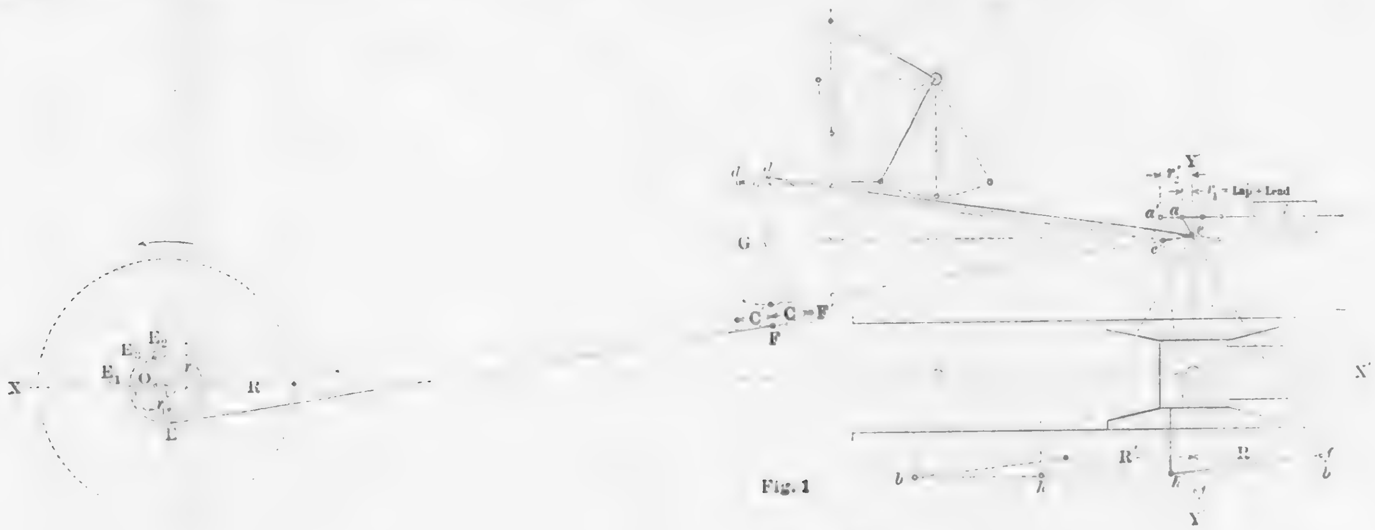


Fig. 1

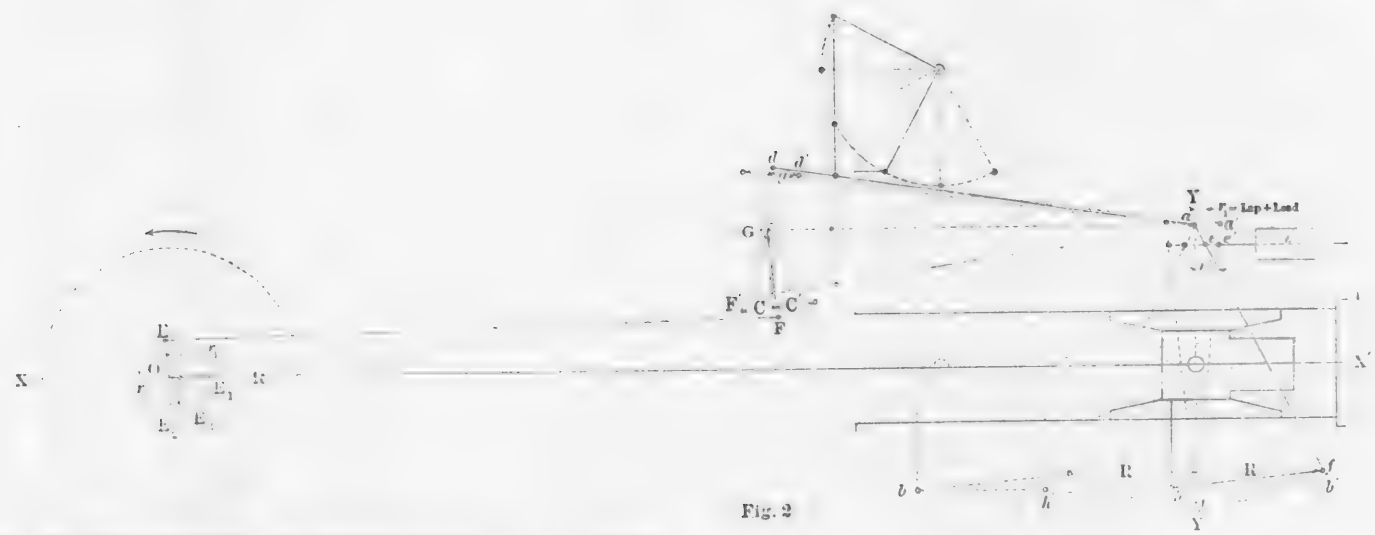


Fig. 2

In the above diagrams the combining lever, a f, is divided into two portions, a e = 2 in. and e f = 24 in.; the link arm G F = 8 in.; the extreme distance of the block pin from the link trunnion d G = 6 in.; the eccentricity of the eccentric O E = 3.5 in., and the crank radius R = 12 in.

These dimensions, although differing considerably from those of American locomotive practice, have been selected because, by their exaggeration of certain of the proportions of actual Walschaert valve motions, they render the drawings clearer than would otherwise be the case.

With the outside admission valve gear Fig. 1, the fulcrum of the combining lever is at e, and assuming this point to be stationary (i. e., disregarding the minute vertical motion of e caused by the rectilineal path of a, enforced by the valve stem guide i)[2], if the union link, h f, is made to vibrate through equal angles above and below the horizontal line b b', it is evident that R' = R = the crank radius, and the maximum valve displacement from mid-position due to the crosshead; or the radius, r_1, of an eccentric O E_1, which with 90° angular advance will, if connected directly to the valve, give the latter the same movement that it would derive from the crosshead alone, provided the crosshead motion was harmonic, is given by the proportion:

r_1 : a e : : R : e f, (sim. rt. triangles)

$$\therefore r_1 = \frac{a\,e}{e\,f} R \dots\dots (1)$$

$$= \frac{2}{24} \times 12 = 1 \text{ in.}$$

$$\text{Conversely, } a\,e = \frac{r_1}{R}\, e\,f = \frac{1}{12} \times 24 = 2 \text{ in.}$$

For the inside admission gear Fig. 2, the fulcrum of the combining lever is at a, and with the preceding assumptions, we have:

r_1 : a e : : R : a f,

$$\therefore r_1 = \frac{a\,e}{a\,f} R \dots\dots (2)$$

$$= \frac{2}{26} \times 12 = 0.923 \text{ in.}$$

$$\text{Conversely, } a\,e = \frac{r_1}{R}\, a\,f = \frac{0.923}{12} \times 26 = 2 \text{ in.}$$

In this case, to obtain a maximum valve displacement r_1 = 1 in., we must make

$$a\,e = \frac{1}{12} \times 26 = 2.167 \text{ in.}$$

$$\text{whence, } r_1 = \frac{2.167}{26} \times 12 = 1 \text{ in., as required.}$$

[1]Peabody's "Valve Gears for Steam Engines," p. 139.

[2]In Fig. 1, if the angle a e Y = 30° (it should never exceed this value), then, as the combining lever swings from the perpendicular to either of the extreme positions, the fulcrum, e, rises vertically a distance ea vrs. sin. a e Y = 2 × 0.13397 = 0.27 in.; while in Fig. 2, an equal angular displacement of the lever from mid-position causes the fulcrum, a, to fall the same inappreciable amount.

From the foregoing it follows that assuming the motion of the crosshead to be harmonic, and ignoring the very slight inaccuracy resulting from the combined effect of the vertical movement of the fulcrum of the combining lever and the angular vibration of the union link, then with outside admission valve gear, at any crank angle, θ, the displacement of the valve from its central position, due to the crosshead alone, is

$$e_1 = r_1 \cos\theta = \frac{ae}{ef} R \cos\theta \quad \ldots\ldots\ldots\ldots (3)$$

while for inside admission gear

$$e_1 = r_1 \cos\theta = \frac{ac}{af} R \cos\theta \quad \ldots\ldots\ldots\ldots (4)$$

In both of the above diagrams, when the crank-pin is at either dead point, the eccentric O E, and the link arm G F, are perpendicular to the center line O F, and disregarding the small discordance caused by the obliquity of the eccentric rod in conjunction with the vertical motion of the link pin F, then $c' = c =$ the eccentricity O E; and assuming the link block to be stationary in the link (i. e., ignoring the block slip), we have:

$$g : d'G :: c : GF', \text{ (sim. rt. triangles)}$$

whence, by substitution,

$$g : dG :: OE : GF,$$

$$\therefore g = OE \frac{dG}{GF},$$

"With the limited amount it is advisable to allow in raising and lowering the link block in reversing the motion, we can without practical error consider the half-movement of the link block, d, to be the same as that of the points e''[3] and a, in Figs. 1 and 2, respectively; hence for any grade,[4] d G, of the link, the half-travel of the combining lever fulcrum, viz.:

$$ee' \text{ or } aa', = OE \frac{dG}{GF}.$$

Consequently, if we eliminate the effect of the crosshead motion upon the valve action (by uncoupling the connecting rod and blocking the crosshead at half stroke), and take d G equal to the full-gear distance of the block pin from the link trunnion, it is evident that with the outside admission valve gear Fig. 1, the maximum valve displacement from mid-position due to the eccentric O E; or the radius, r_2, of an equivalent eccentric O E_2, which with zero angular advance will, if connected directly to the valve, give the latter the same movement that it derives from the actual eccentric through the medium of the combining lever and link, is given by the proportion:

$$r_2 : a'f' :: ee' : e'f', \text{ (sim. rt. triangles)}^{5}$$

which by substitution becomes,

$$r_2 : af :: OE \frac{dG}{GF} : ef.$$

$$\therefore r_2 = OE \frac{dG}{GF} \times \frac{af}{ef} \quad \ldots\ldots\ldots\ldots (5)$$

$$= 3.5 \times \frac{6}{8} \times \frac{26}{24} = 2.84 \text{ in.}$$

$$\text{Conversely, } OE = \frac{r_2}{\frac{dG}{GF} \times \frac{af}{ef}} = r_2 \times \frac{GF}{dG} \times \frac{ef}{af} = 2.84 \times \frac{8}{6} \times \frac{24}{26} = 3.5 \text{ in}$$

For the inside admission gear Fig. 2,

$$r_2 : e'f' :: aa' : a'f',$$

and by substitution,

$$r_2 : ef :: OE \frac{dG}{GF} : af.$$

$$\therefore r_2 = OE \frac{dG}{GF} \times \frac{ef}{af} \quad \ldots\ldots\ldots\ldots (6)$$

$$= 3.5 \times \frac{6}{8} \times \frac{24}{26} = 2.423 \text{ in.}$$

$$\text{Conversely, } OE = r_2 \times \frac{GF}{dG} \times \frac{af}{ef} = 2.423 \times \frac{8}{6} \times \frac{26}{24} = 3.5 \text{ in}$$

In this case, to obtain a maximum valve displacement $r_2 = 2.84$ in., we must make

$$OE = 2.84 \times \frac{8}{6} \times \frac{26}{24} = 4.102 \text{ in.;}$$

$$\text{whence, } r_2 = 4.102 \times \frac{6}{8} \times \frac{24}{26} = 2.84 \text{ in., as required.}$$

From the preceding analysis it follows that disregarding the irregularities produced by the block slip, and the angularities of the eccentric rod, link arm and radius bar, then with outside admission valve gear, for a given grade, d G, of the link, the displacement of the valve from its central position due to the eccentric O E, is

$$e_2 = r_2 \sin\theta = \left[OE \frac{dG}{GF} \times \frac{af}{ef} \right] \sin\theta \quad \ldots\ldots\ldots\ldots (7)$$

and for inside admission gear,

$$e_2 = r_2 \sin\theta = \left[OE \frac{dG}{GF} \times \frac{ef}{af} \right] \sin\theta \quad \ldots\ldots\ldots\ldots (8)$$

Now, the entire displacement, e, of the valve at any crank angle is evidently the sum of the displacements of the two independent sources, namely, the crosshead and the eccentric; therefore, with outside admission valve gear, from equations 3 and 7 we have:

$$e = e_1 + e_2 = r_1 \cos\theta + r_2 \sin\theta = \frac{ae}{ef} R \cos\theta + \left[OE \frac{dG}{GF} \times \frac{af}{ef} \right] \sin\theta \quad \ldots\ldots\ldots\ldots (9)$$

while for inside admission gear, from equations 4 and 8 we obtain:

$$e = e_1 + e_2 = r_1 \cos\theta + r_2 \sin\theta = \frac{ac}{af} R \cos\theta + \left[OE \frac{dG}{GF} \times \frac{ef}{af} \right] \sin\theta \quad \ldots\ldots\ldots\ldots (10)$$

and since r_1 and r_2 are constant for any grade of the link, r_1 and r_2 (i. e., the radii of the virtual eccentrics, O E_1, and O E_2, at 90° to each other) are the coördinates of the diameter of the valve circle in the Zeuner diagram, for that grade of the gear.

Thus, referring to the Zeuner diagram Fig. 3, it is evident that with the outside admission valve motion, Fig. 1, in full back gear, when the crank is at the front dead point A', the centers of the equivalent eccentrics are at E_1 and E_2; hence at any crank angle, the actual displacement of the valve, derived from both sources, is the displacement due to the combined or resultant eccentric O E_3

$$= \sqrt{\overline{OE_1}^2 + \overline{OE_2}^2} = \sqrt{r_1^2 + r_2^2}$$

$$= \sqrt{\left(\frac{ac}{ef} R\right)^2 + \left(OE \frac{dG}{GF} \times \frac{af}{ef}\right)^2} \quad \text{(equations 1 and 5)}$$

$$= \sqrt{\left(\frac{2}{24} \times 12\right)^2 + \left(3.5 \times \frac{6}{8} \times \frac{26}{24}\right)^2}$$

$$= \sqrt{1^2 + 2.84^2} = \sqrt{9.0656} = 3 \text{ in. (almost exactly);}$$

---

[3] "Walschaert Valve Gear as applied to Large American Locomotives," p.p. 34-35; The American Locomotive Company, 1906.

[4] By the term "grade of link" is meant the position of the link block in the link, as at full-gear, half-gear, mid-gear, etc.

[5] Owing to the rectilineal paths of a, Fig. 1, and of e, Fig. 2, due to the valve stem guide i, in both cases the fulcrum of the combining lever describes a line that is, with sufficient accuracy for present purposes, a right line perpendicular to Y Y'; hence the above proportions based upon the relations of the sides of similar triangles.

for which eccentric the investigation of the valve action during a complete revolution is obviously accomplished by means of the valve circles o b and o b″ in the usual manner.[6]

Also, since the radius and position of the eccentric $O E_1$, is constant for all grades of the link, while equation 5 indicates that the eccentricity, r_2, of $O E_2$, varies directly as the distance,

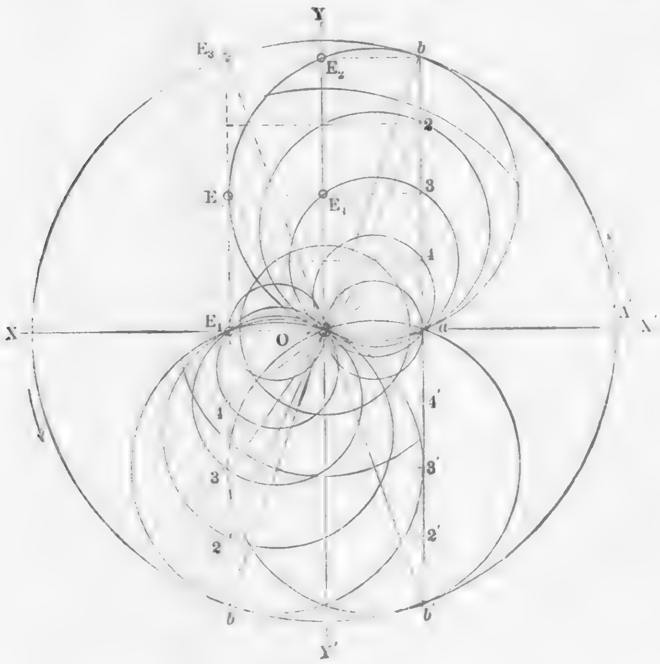


Fig. 3.

d G, of the block pin from the link trunnion, it follows that at half-gear the centers of the equivalent eccentrics are at E_1 and E_4; the resultant eccentric $O E_5$

$$= \sqrt{\left(\frac{2}{24} \times 12\right)^2 + \left(3.5 \times \frac{3}{8} \times \frac{26}{24}\right)^2}$$

$$= \sqrt{1^2 + 1.42^2} = \sqrt{3.0164} = 1.73 \text{ in. (very approximately)};$$

the analysis of the valve movement is made by the circles 0 3, 0 3″; and similarly for all other grades of the link from full backward to mid-gear. At the latter point, $r^2 = 0$, and for both directions of rotation, the valve displacements are given by the circles Oa, OE_1.

In the Zeuner diagram Fig. 4, for the inside admission valve motion, Fig. 2, when the crank is at the front dead point and the link in full back gear, the centers of the equivalent eccentrics are evidently at E_1 and E_2; the resultant eccentric $O E_3$

$$= \sqrt{\overline{O E_1}^2 + \overline{O E_2}^2} = \sqrt{r_1^2 + r_2^2}$$

$$= \sqrt{\left(\frac{a\,e}{a\,f} R\right)^2 + \left(O E \frac{d\,G}{G\,F} \times \frac{e\,f}{a\,f}\right)^2} \text{......, (equations 2 and 6)}$$

$$= \sqrt{\left(\frac{2}{26} \times 12\right)^2 + \left(3.5 \times \frac{6}{8} \times \frac{24}{26}\right)^2}$$

$$= \sqrt{0.923^2 + 2.423^2} = \sqrt{6.7083} = 2.59 \text{ in. (almost exactly)};$$

and the valve action is represented by the valve circles o b, o b″, as before.

At half-gear, the equivalent eccentric centers are at E_1 and E_4: the resultant eccentric $O E_5$

$$= \sqrt{\left(\frac{2}{26} \times 12\right)^2 + \left(3.5 \times \frac{3}{8} \times \frac{24}{26}\right)^2}$$

$$= \sqrt{0.923^2 + 1.211^2} = \sqrt{2.316} = 1.52 \text{ in. (very approximately)};$$

the valve displacements are obtained from the circles 0 3, 0 3″; and likewise for all back gear positions of the link block.

It is therefore apparent that the motion imparted by the Walschaert gear to both outside and inside admission valves can be approximately represented by Zeuner's valve diagrams similar to those used for the Gooch link motion, or for a shifting eccentric with constant lead. "As usually constructed," the Walschaert "gear does not give harmonic motion to the valve, for the motion of the crosshead of the engine with the usual proportions of locomotives has considerable irregularity on account of the angularity of the connecting rod; also some irregularity is introduced by the combining lever a f. Consequently such" diagrams as Figs. 3 and 4, "can be of use only in roughly blocking out a gear. The real action

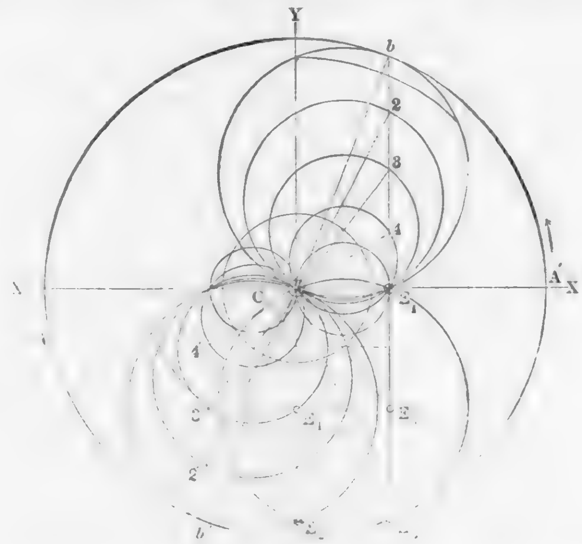


Fig. 4.

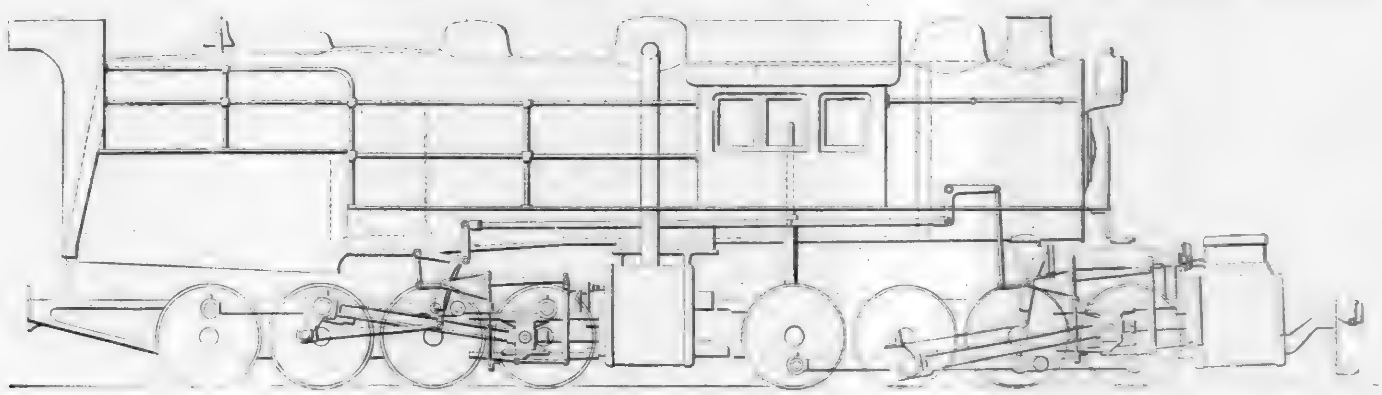
of the gear can be determined either by constructing diagrams similar to" Figs. 1 and 2 "on as large a scale as convenient, or by aid of a model. A combination of the two methods, similar to the skeleton model for link motions, may be found convenient for this purpose. Since part of the motion of the valve is derived from the crosshead, the adjustment of the gear to give equal cut-off will generally be easier than for a link motion."[7]

[6]For a full explanation of the construction and use of the Zeuner diagram, refer to Peabody's "Valve Gears for Steam Engines;" also to Henderson's "Locomotive Operation," p.p 86-97.

[7]Peabody's "Valve Gears for Steam Engines," p. 85.

QUALIFICATIONS OF AN ENGINEER.—It is my constant observation of four engineering works, employing about 20,000 men, that engineers reach the limit of their usefulness from defects of character, rather than from want of technical attainments. Our greatest difficulty is to find courage, candor, imagination, large vision and high ambition. I do not know which of these qualities is most often lacking, or which is most essential. The lack of courage and candor comes most often to my notice, but the lack of imagination and of broad outlook produces the most serious disasters. All of these things an engineer must have if he is to go far, and all of these any citizen must have if he is to go far in the work of life. Our scheme of education will be radically defective if it does not provide for the development of courage and candor, of imagination and broad vision and high ambition.—*Col. H. G. Prout.*

THE STEEL TIE.—Take any period of five years, and the interstate reports show that tie renewals are from two to two and a half times the cost of the renewal of rails. On the assumption that the steel tie can be produced at the same price per pound as the steel rail and that the life of the steel tie will be one and a half times that of the steel rail, the cost of tie renewal would be about equal to that of rail renewal. Experience in Europe and observation from our own experience here indicate that a longer life will be obtained. The possible reduction of cost of tie renewals to the same cost as rail renewals shows the great economy obtainable from the use of steel ties. A portion of this reduction is due to being able to sell the old tie for scrap for 40 to 50 per cent. of its original cost.—*Mr. H. T. Porter, before the Railway Club of Pittsburgh.*



MALLET ARTICULATED COMPOUND LOCOMOTIVE 0—8—8—0 TYPE, ERIE R. R.

HEAVIEST LOCOMOTIVE IN THE WORLD.

ERIE RAILROAD.

The American Locomotive Company are preparing designs for three Mallet articulated compound locomotives for the Erie Railroad, of which the accompanying illustration is a preliminary outline diagram. These locomotives will weigh approximately 410,000 lbs., all on drivers, and hence will be by far the heaviest locomotives in the world, exceeding the previous Mallet compounds built in this country in all respects, as can be seen by reference to the accompanying table giving the comparative dimensions with the ones built for the Great Northern Railway by the Baldwin Locomotive Works, which were illustrated in this journal in October, 1906, page 371, and the Baltimore & Ohio locomotives built by the American Locomotive Company, which were illustrated in this journal in 1904 and 1905.

Road	Balt. & Ohio.	Great North.	Erie
Builder	American.	Baldwin	American.
Wheels	0—6—6—0	2—6—6—2	0—8—8—0
Total weight	334,500 lbs.	355,000 lbs.	410,000 lbs. est.
Weight on drivers	334,500 lbs.	316,000 lbs.	410,000 lbs. est.
Size of cylinders	20&32x32 in.	21½&33x32 in.	25&39x28 in.
Diameter of drivers	56 in.	55 in.	51 in.
Tractive effort	71,500 lbs.	71,600 lbs.	98,000 lbs.
Steam pressure	235 lbs.	200 lbs.	215 lbs.
Total wheel base	30 ft. 8 in.	44 ft. 10 in.	39 ft. 2 in.
Driv. wheel base rigid	10 ft.	10 ft.	14 ft. 3 in.
Total heating surface	5,585 sq. ft.	5,658 sq. ft.	6,108 sq. ft.
Grate area	72.2 sq. ft.	78 sq. ft.	100 sq. ft.

The preliminary announcement of these locomotives indicates that they will have a number of very interesting features. It can be seen that there will be 16 drivers, or four pairs on each of the two groups; that the boiler will have 21-ft. flues and a 4-ft. combustion chamber, which makes the boiler shell probably the longest ever built for a locomotive; the total heating surface will be over 6,000 sq. ft., and the grate will have an area of 100 sq. ft.; the low-pressure cylinders will be 39 ins. in diameter and the high-pressure 25 ins., the stroke in both being 28 in. and the tractive effort will be 98,000 lbs.

As the design of these engines is in a preliminary stage, very little can be given as regards details at this time, but we hope in a later number to illustrate all the interesting features of these monster machines. The general dimensions and estimated weights available are as follows:

MALLET ARTICULATED COMPOUND LOCOMOTIVE 0—8—8—0 TYPE.

ERIE RAILROAD.

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. coal
Tractive effort	98,000 lbs.
Weight in working order, estimated	410,000 lbs.
Weight on drivers, estimated	410,000 lbs.
Weight of engine and tender in working order, estimated	573,000 lbs.
Wheel base, driving	14 ft. 3 in.
Wheel base, total	39 ft. 2 in.
Wheel base, engine and tender	72 ft. 2 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.18
Tractive effort × diam. drivers ÷ heating surface	820
Total heating surface ÷ grate area	61
Firebox heating surface ÷ total heating surface, %	5.7
Weight on drivers ÷ total heating surface	67
CYLINDERS.	
Kind	Compound
Number	4
Diameter and stroke	25 & 39x28 in.
VALVES.	
Kind	H. P. Piston
Kind	L. P. Bal. Slide
WHEELS.	
Driving, diameter over tires	51 in.
Driving, thickness of tires	3½ in.
BOILER.	
Style	Conical
Working pressure	215 lbs.
Outside diameter of first ring	84 in
Firebox, length and width	126 x 114 in
Firebox, combustion chamber, length	48 in.
Tubes, number and outside diameter	468 2¼ in
Tubes, length	21 ft.
Heating surface, tubes	5,760 sq. ft.
Heating surface, firebox	348 sq. ft.
Heating surface, total	6,108 sq. ft.
Grate area	100 sq. ft
TENDER.	
Water capacity	8,500 gals.
Coal capacity	16 tons

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION.

The fifth annual convention of this association was held at "The Breslin," New York, on October 9th and 10th, and was one of the best, from the standpoint of attendance, ever held by the association, which now includes about 80 of the most important machine tool builders of the country. Of these 15 applied for membership at this meeting, indicating that the benefits possible by identification with the association are being more generally realized.

Mr. E. P. Bullard, Jr., Bridgeport, Conn., presented a paper on the subject of "apprenticeship," which was enthusiastically received. This paper served as a report of the committee appointed at a previous meeting to investigate this subject and recommend a standard system to be followed throughout the country offering inducements to young men to learn the machinist trade. The committee was continued, and it is expected that definite action, in the way of adoption of the standard suggested, will be taken at the next meeting.

Mr. J. M. Gunn, New York, delivered an address on the subject of "Costs," in which he pointed out that the association could accomplish much good for its members by adopting a uniform system of determining costs. He said that it did not make so much difference which system was adopted as long as it was uniform. A committee was appointed to investigate the subject and report at the next meeting.

The entertainment features consisted of a luncheon at the Hotel Imperial, tendered by the Hill Publishing Company, and a boat ride to West Point, tendered by the Industrial Press.

The following officers were elected for the ensuing year: President, E. M. Woodward, Worcester, Mass.; 1st vice-president, Wm. Lodge, Cincinnati, O.; 2d vice-president, F. E. Reed, Worcester, Mass.; treasurer, W. P. Davis, Rochester, N. Y., and secretary, P. E. Montanus, Springfield, O.

(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE.

J. S. BONSALL,
Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT,
E. A. AVERILL, } Editors.

NOVEMBER, 1906.

Subscriptions.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

Remit by Express Money Order, Draft or Post Office Order.

Subscription for this paper will be received and copies kept for sale by the
Post Office News Co., 217 Dearborn St., Chicago, Ill.
Damrell & Upham, 283 Washington St., Boston, Mass.
Philip Roeder, 307 North Fourth St., St. Louis, Mo.
R. S. Davis & Co., 346 Fifth Ave., Pittsburgh, Pa.
Century News Co., 6 Third St., S. Minneapolis, Minn.
W. Dawson & Sons, Ltd., Cannon St., Bream's Buildings, London, E. C., England.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase of construction.*

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There seems to be a marked tendency to abolish the system of special apprenticeship and to have the college graduate start to work under the same conditions as the ordinary apprentice. This is as it should be. The practice of placing special apprentices in the shop tends to discourage not only the regular apprentices but the mechanics as well, since it is practically understood that the special apprentice will be pushed along and promoted over their heads. In a great many instances the "special" has been given a better class of work, which, however, could usually be handled almost equally as well by the regular apprentice, who would, undoubtedly, be greatly encouraged if allowed to do such work as a reward for careful and conscientious effort. The fact that the "special" has been allowed to do so much of this work has also been a bad thing for him, as the time spent in the shop is so short that all of it should be devoted to doing and studying the regular operations and in getting into close touch with the men, so that he will not only be in a position to know how to handle them to get the best results, in event of his being promoted, but will also know how to properly issue instructions concerning work to be done.

The personnel of the average railroad drawing room force is continually changing, and much time is usually lost in instructing new men as to the methods in use in each particular drawing room. On one road the mechanical engineer and chief draftsman, out of pure self-defense, got up an eight-page blue-print pamphlet, about 9 by 12 ins. in size, giving instructions as to the standard sizes of drawings, rules as to dimensioning, scales, lettering, methods of projecting, cross sectioning, information as to titles, pattern numbers and shop cards, drawing numbers, references on the drawings, revisions, and builders' prints. Not only did these result in a considerable saving in time in the drawing room, but they made it possible to turn out more uniform drawings, thus making it easier for the men in the shop to follow them and use them properly.

A novel method of checking the efficiency of employees, which is made possible by the use of electrically driven machinery, has been introduced in the works of the Firth-Sterling Company. It consists of placing in a convenient location for observation a recording ammeter, arranged to be connected in circuit with any machine whenever desired. Previous tests have determined approximately the current required for a given class of work, so that the record of the ammeter indicates whether or not the machine is working up to its capacity and the time it stands idle. In another works where this was tried it was found that, aside from the question of the efficiency of employees, the curves obtained afforded a means of locating weak spots in setting the work in place and handling it to and from the the machine. Very often the actual time the machine was in operation was a surprisingly small percentage of the working day, and by following up instances of this kind it was possible to considerably improve the output.

The reasons for the widespread popularity of the Walschaert valve gear on American Railroads were put into a nutshell by Mr. A. W. Gibbs, whose remarks are quoted in full on the opposite page, at the September meeting of the New York Railroad Club when he stated that the advantages of this gear, as he saw it, were entirely mechanical. The Pennsylvania Railroad, which has long been noted for its carefulness in taking up any radical departures in locomotive design, now has over 400 locomotives, both freight and passenger, equipped with the Walschaert valve gear, this being more than any other company in the country has at present. In enumerating the features of the design, which has led the company to equip this large number of engines on a comparatively short trial, Mr. Gibbs makes prominent the following features: First, that it was found that the valves operated by the Walschaert valve gear remain square a much longer time

than with the Stephenson motion. This one feature goes far to off-set the probably better general steam distribution obtained by means of the latter valve motion, for, of course, if the valves do not remain as they were originally set the economy to be derived from that setting is lost. Second, the opportunity given to properly and rationally brace and stiffen the main frames by the removal of the valve motion parts from between the frames; and third, the accessibility of the motion for inspection and repair, which naturally results in its being maintained in a better condition.

The only argument advanced in the discussion as opposed to the gear was the fact that it gives a constant lead for all points of cut-off, and hence is not as flexible, that is, will not give as good steam distribution under different and varied speed conditions. The constant lead is an inherent feature of the gear and theoretically it is a very distinct disadvantage when applied to a locomotive which is to be operated under conditions requiring any considerable range of speed; but practically, the fact mentioned by Mr. Gibbs, which is not at all unusual, that with the Stephenson gear on large engines, the engineer is often afraid to move the reverse lever and place it in an economical position for fear of being thrown through the front window, considerably lessens the effectiveness of this argument. It is stated that thus far the Pennsylvania Railroad has not found the tractive effort of these locomotives to be less than those of the Stephenson link motion, although complete tests have not yet been finished.

The primary cause of the introduction of the Walschaert valve gear in this country is the big locomotive and the reasons for its adoption are purely mechanical.

In a communication on another page Mr. Coleman has called attention to the fact that as at least 99 per cent. of the actual work in repairing or building locomotives is done by the ordinary mechanic, it is of prime importance if the quality of the shop output is to be improved and the amount increased that the individual mechanic be carefully studied in order to improve his condition and spur him on to greater effort. Very often an ambitious mechanic becomes discouraged because, after he has gotten up some device or idea for improving the production, a superior officer is given the entire credit for it. This not only discourages the man from trying to make additional improvements, but it indirectly works against the officers in charge, since they lose the co-operation of the men in improving conditions. The shop superintendent who makes the best record is the one who sees that credit is given where it is due, and thus spurs the men on to greater efforts.

An interesting plan which was observed by Mr. G. M. Basford while visiting the works of Mr. A. Borsig, at Tegel, Germany, was described on page 319 of our September, 1905, issue, and is as follows: "In every shop a letter-box is put in a conspicuous place, and the men are asked to submit in writing suggestions for improving the work of the plant or decreasing its cost. This is not original at Tegel, it is in use in many shops, but by close attention from Mr. Dorn, the manager of the works, fifty good suggestions have been put into effect in about a year and a half. The suggestions are usually accompanied by sketches, and sometimes by very good drawings. The subjects are gone into very carefully, and those having sufficient merit are put into effect, suitable records being made in a book. Employees receive cash prizes for their suggestions, the amounts varying from very little up to about $100. More than this would be paid for a specially good thing. This works very well in Germany, where the men are much steadier than in some newer countries. It should work even better in the United States, and it seems a little strange that railroads do not carry out an idea of this kind." Even if it was not thought practical to give cash prizes, think of the encouragement the men would receive if the superintendent of motive power should send them a personal letter expressing appreciation of their work, or if when he visited the shop he should look the man up and give him a good, hearty handshake and thank him for what he had done.

1907 CONVENTIONS OF THE M. M. AND M. C. B. ASSOCIATION.

At the meeting of the officers and executive committees of the American Railway Master Mechanics' Association, Master Car Builders' Association and the Supply Mens' Association to decide on the place of meeting for the conventions to be held in June, 1907, which took place in New York on October 29, it was unanimously decided to again meet at Atlantic City. The steel pier, which has been considerably enlarged since last year, will be used for the exhibits, and the regular meetings will be held in the "Sun Parlor," as before. The opening sessions only will be held in the ball room on the steel pier. The headquarters of the convention, however, will be at the Marlborough-Blenheim, and the balls and evening entertainments will be held in the large ball room of the new million-dollar pier, which is now approaching completion and is located near the headquarters.

Special arrangements are to be made in the location of the exhibits, so that nothing of a noisy nature will be in the vicinity of the meeting hall. The general appearance of the exhibit booths and their arrangements is to be given more careful attention and, in fact, all the unpleasant or undesirable features which developed during the previous experience will be eliminated as far as possible.

THE WALSCHAERT VALVE GEAR ON THE PENNSYLVANIA RAILROAD.

At the September meeting of the New York Railroad Club, in discussing Mr. Kennedy's paper on "The Walschaerts Valve Gear as Applied to Locomotives," Mr. A. W. Gibbs, general superintendent of motive power of the Pennsylvania Lines east of Pittsburgh and Erie, spoke as follows concerning the reasons for the introduction of this gear on that railroad and the results so far attained:

"The Pennsylvania Railroad having introduced the Walschaert valve gear on a rather large scale, it would not be amiss to consider the conditions that led to the change from Stephenson link heretofore used.

"In the older types of locomotives, with which we are all familiar—more particularly in the eight-wheel type—where fairly long and straight eccentric rods could easily be employed, the service rendered by the Stephenson link motion was entirely satisfactory. The steam distribution was then very good; the wear and tear of parts small; the handling of the reverse lever easy, and all parts of the motion were readily accessible.

"When we departed from the simple eight-wheel type and introduced additional driving wheels, filling up the space between them with spring rigging, brake shoes and other devices, the situation at once became more complicated. We were then confronted with the necessity of either using bent eccentric rods, in order to get adequate length and at the same time clear the axle, or to use very short rods and various forms of extension by which to finally reach the valve. The increasing size of axles, and the greater throw of eccentrics, required a very large sheave, and with the lateral play that accumulates in the boxes and with the shortness of the rods, the binding effect of the straps on the eccentrics becomes a very serious matter; and I think all of us who have had experience with this type of equipment realize that not only is there very rapid wear of the eccentrics themselves, but have also experienced difficulties from the breakage of the supports for hanging the links. The inaccessibility of the motion in this same type of locomotive is such that the attention which it receives is by no means equal to that formerly given, and the inertia due to the increasing weight of the parts seems to be a very potent factor in shortening the life of the motion as a whole. In other words, when put right, it will not stay put.

"It has long seemed to me that there is a striking analogy between our shifting link motion and the Prony brake. The four straps, with their rods, each form a brake, and the pull

of these four brakes is all transmitted to the lift shaft and thence to the reverse lever. The tendency is for the forward ends of these four brakes to revolve with the axle, so that, granting that the balancing springs were right for an engine in the standing position, it was entirely inadequate for the same engine while running. We all know of engines which the runners are afraid to handle while running, for fear of being pulled through the front of the cab, with the result that the reverse lever once set in its position on the quadrant remains in that position, up hill and down dale, to the next stop and start, and we all know of the cut seats from drifting with the lever in that position. Such refinements as closer graduation of the quadrants to enable the locomotives to be run at the most economical cut-off then become superfluous under such circumstances when the enginemen dare not move the lever to put it in such economical position.

"The reason for becoming dissatisfied with the Stephenson link motion, therefore, as I see it, was purely mechanical; and had we continued to stick to the older types of locomotives our attention would probably not have been called to the necessity for a change.

"The history of the use of the Walschaert valve gear on the Pennsylvania Railroad dates from the importation of the DeGlehn locomotive, which was constructed at the Belfort (France) works of the Societe Alsacienne de Constructions Mecaniques, and exibited and tested at the Louisianna Purchase Exposition in St. Louis in 1904, and has since been doing excellent work on the road. Not the least of the considerations which led to this importation was that we might learn from it many details which could advantageously be applied to our own equipment and, even granting the engine as a whole might not suit our conditions, that, nevertheless, the value of the lessons to be learned from it would fully justify the expense of the experiment, and I am glad to say that these expectations have been fully realized.

"This DeGlehn locomotive, as you probably know, is of the balanced compound type, with independent valve motions for the high and low pressure engines, being operated from one screw shaft so arranged that the screw actuating the low-pressure levers can be disengaged at will, so that in practice the low-pressure cut-off is usually placed so as to give from 65 to 70 per cent. cut-off, further adjustments being made in the high-pressure cut-offs.

"As compared with our own valve motions, that of the DeGlehn locomotive is everywhere exceedingly light. Some of the details, such as the links, while beautifully designed, are expensive to construct and, unless a high grade of workmanship is obtained, are liable to give trouble.

"Among the features very noticeable in the Walschaert gear of this DeGlehn locomotive is the care that has been taken to get all the working parts in one vertical plane. On the high-pressure engine, which is outside of the frames, it has been practicable to do this by offsetting the high-pressure valve chests and still keep them within our clearance limits. In the low-pressure engine the motion is taken by one eccentric for each cylinder, and in this case a rocker with double bearings is employed to reach the proper valve center. This eccentric strap appears to us to be insignificant in its bearing surface—merely 2 ins. long, lined with white metal. Nevertheless, its wear has been very satisfactory, indicating how small is the work to be performed. The entire adjustment of this motion is at a small crosshead which guides the valve stem, and all pin fits throughout are straight ones.

"Our first application of Walschaert valve gear, next succeeding that on the DeGlehn locomotive, was to a small trial lot of ten Consolidation type locomotives—part of a large order then under construction that had been placed early in 1905—which ten engines were distributed over all grand divisions of the road, with the hope that we might have ample time to test them before deciding what type of motion should be applied to the next order of about 160 Consolidation locomotives. There were such delays in the completion of this small lot of ten locomotives with the Walschaert gear that in a little over one month after they were turned out we had to decide the question, but by that time the reports received from the road people were so favorable that we did not hesitate to continue the application of the Walschaert motion.

"We have since applied this Walschaert valve gear to our Atlantic type locomotives, so that at the present time we have 352 locomotives so equipped on the lines east of Pittsburgh, and on the lines west some fifty-five more, a total of more than four hundred locomotives.

"Being particularly anxious to retain the principle that this Walschaert gear should be in one vertical plane, we decided (for both the Consolidation and Atlantic types) that rather than to use rockers to actuate slide valves, we had better change to the piston valve offset to the limit of our clearances, and this has been done.

"It is too early as yet to express final opinion as to the wisdom of the change, as the locomotives have not been in service long enough to require heavy repairs.

So far as we have gone, however, particularly with freight locomotives, the opinion is entirely favorable, and while there are some valves out of adjustment, due to tampering with the adjusting nuts, it is noticeable that the lame engines are seldom among those equipped with the Walschaert gear.

"Preliminary experiments with the dynamometer car indicate that the drawbar pull is certainly no less than that of similar locomotives equipped with the Stephenson link motion and slide valves.

"Contrary to our expectations, no protest whatever came from the road when these Walschaert gear locomotives were introduced, the road people without exception placing high value on the accessibility of the gear.

"Indirectly, other benefits have followed the introduction of the Walschaert valve gear. The absence of the link motion very much facilitates attention to the driving boxes, and, for the same reason, it has been practicable to introduce strong bracing between the frames in order to lessen what has been one of our greatest sources of expense in locomotive maintenance, namely, frame breakage.

"Further than this I am not prepared to go, as dynamometer trials have not been completed, nor have any of these Consolidation locomotives with the Walschaert gear been placed on the locomotive testing plant.

"As a method of steam distribution, I am unable to see that the Walschaert gear differs much from the Stephenson link motion, further than that a gear which is square, and remains so, is to be preferred to one in which various sources of lost motion combine to render the actual distribution very different from that figured on the drawing board. The effect of the constant lead is not noticeable in the performance. In other words, the advantages of the Walschaert gear, as I see them at present, are purely mechanical. The breakages have been very few and were readily remedied; and, if the future history confirms the earlier showing, I believe that, from the transportation side, the locomotives with the Walschaert gear will be very popular, owing to absence of breakdowns on the road."

STATISTICS OF RAILWAYS IN THE UNITED STATES

The eighteenth annual report of the Interstate Commerce Commission for the year ending June 30, 1905, contains some very interesting figures on the statistics of railroads in the United States. It shows that the total single track mileage at that time was 218,101 miles, or over 4,000 miles more than the preceding year. The total mileage, including tracks of all kinds, was 306,796.74 miles, an increase of very nearly 10,000 miles, of which over 35 per cent. represents extension of yard track and sidings. The number of railway corporations for which mileage is included in the report was 2,167. The number of roads in the hands of receivers was 26, with a mileage of 795.82 miles.

The number of locomotives in service on June 30, 1905, was 48,357, an increase during the year of 1,614. The total number of

cars of all classes was 1,842,871, an increase of over 44,000. This was divided between passenger service cars numbering 40,713, freight cars, 1,731,409, and company service cars. These figures do not include cars owned by private commercial firms or corporations. The average number of locomotives per 1,000 miles of line was 223; the average number of cars, 8,494. The number of passenger miles per passenger locomotive was 2,048,558, an increase over the previous year of 100,174. The number of ton miles per freight locomotive was 6,690,700, an increase of 233,854.

The number of persons on the pay rolls of railroads in the United States on June 30, 1905, was 1,382,196, which is equivalent to an average of 637 employees per 100 miles of line, an increase of 26. The total number of railroad employees, disregarding a small number not assigned, were apportioned as follows: For general administration, 54,141; for the maintenance of way and structures, 448,370; for the maintenance of equipment, 281,000, and for conducting transportation, 595,456. The total amount of wages or salary paid to the employees during the year was $839,944,680.

The par value of the railway capitalization outstanding was $13,805,258,121, which is equivalent to a capitalization of $65,926 per mile. Of the total capital stock, 37.16 per cent. paid no dividends. The amount of dividends declared during the year was equivalent to 5.78 per cent. on a dividend-paying stock.

The number of passengers carried during the year was 738,834,667, being 23,414,985 more than during the previous year. The passenger mileage, or number of passengers carried one mile, was 23,800,149,436, the increase being nearly two billion. The ton mileage was 186,463,109,510, the increase being nearly twelve billion ton miles. The number of ton miles per mile of line was 861,396, indicating an increase in the density of freight traffic of 31,920 ton miles per mile of line. The average revenue per passenger per mile was 1.962 cents. The average revenue per ton mile of freight was 0.766 cents. The ratio of operating expenses to earnings was 66.78 per cent.

The gross earnings per mile of line averaged $9,598, of $292 more than the previous year. The operating expenses averaged $6,409 per mile of line, and the net earnings per mile were thus $3,189.

The total number of casualties to persons on the railways for the year was 95,711, of which 9,702 represented the number of persons killed. Of these, 1,990 were trainmen, 136 were switch tenders and switchmen, and 1,235 were other employees. The number of passengers killed during the year was 537, and 10,457 were injured; of these, 341 passengers were killed and 6,053 injured because of derailments and collisions. The total number of persons, other than employees and passengers, killed was 5,805; injured, 8,718. One passenger was killed for every 1,375,856 carried, and one was injured for every 70,655 carried. One passenger was killed for every 44,320,576 passenger miles, and one injured for every 2,276,002 passenger miles.

WHAT RAILROAD PASSENGERS GET FOR THEIR FARES.

An exhaustive pamphlet on passenger fares has been prepared by Slason Thompson, of Chicago, having special reference to the agitation for a two-cent maximum fare. Tables are submitted to show that the income from passengers alone does not come within $73,000,000 of meeting the expenses of the passenger service of the railroads of the country, while the combined revenue from passengers, mail and express exceeds the cost of operation by only $23,925,105.

Instead of a decrease in the cost of passenger traffic since 1893, the public demand for higher speed, additional trains, more conveniences, and greater safety, has actually advanced the expense beyond what it was when the Interstate Commerce Commission estimated it as 1.955 cents per passenger mile.

The safety, comfort and convenience of the traveling public continuously demand that railways expend liberal sums in putting their service on the most efficient and safe basis. To do this, lines must be double-tracked, bridges and culverts must be strengthened, heavier rails laid, road beds remade, interlocking switches installed, block signals introduced, dangerous grade crossings abolished, and passenger cars must be stronger, better lighted, heated and ventilated.

As an instance of what the railways are doing to meet the public demand for safer and more expeditious passenger service, it may be mentioned that over $32,000,000 has been spent on track elevation in Chicago since 1893, and that before this great work is completed it will cost the roads centering there fully $30,000,000 more.

Compliance with such demands is more important than cheap fares, and yet it is proposed to make the instalment of these improvements more difficult, if not impracticable, by curtailing the income of the railways from the very service in whose interest the expenditures are most clamorously demanded.

What has been done in the matter of increasing the speed and frequency of passenger trains is illustrated by a summary prepared by officials of the Chicago & Northwestern Railway of the number and speed of the trains over the Wisconsin division of that line for the years 1890 and 1905. These show an increase in frequency of passenger facilities of from 25 to 133 per cent., and in average speed from 5 per cent. up to nearly 40 per cent. What is true of this one line in Wisconsin has been duplicated all over the United States, wherever conditions have invited additional transportation facilities.

Aside altogether from the indivisible expenditures involved in making the improvements partly enumerated above, where the cost cannot be apportioned between passenger and freight traffic, there has been a striking advance in the cost of the equipment, material and labor directly chargeable to the passenger service.

The following table shows the increased initial cost of the equipment employed in passenger service:

	1893 Average Cost.	1906 Average Cost.	Increase per cent.
Passenger locomotives	$9,800	$20,000	104
Passenger coaches	5,400	9,000	66
Mail cars	3,900	7,500	92
Baggage cars	3,100	7,000	93

Almost incredible as these advances appear, they are based on the actual purchases of a great Western system during the years in question.

The wages of the men directly employed in the operation of trains show the following increases:

	Average Daily Compensation. 1893.	1905.	Increase per cent.
Engine men	$3.66	$4.16	13.6
Firemen	2.04	2.39	17.2
Conductors	3.08	3.54	15.0
Trainmen	1.91	2.31	21.0

The wages of all other employes concerned in the movement of passenger trains show proportionate advances.

Coincident with this noteworthy advance in the wages of train crews, the number of this class of railway employes has increased from 179,636 in 1893 to approximately 262,000 in 1905, or 45.8 per cent.

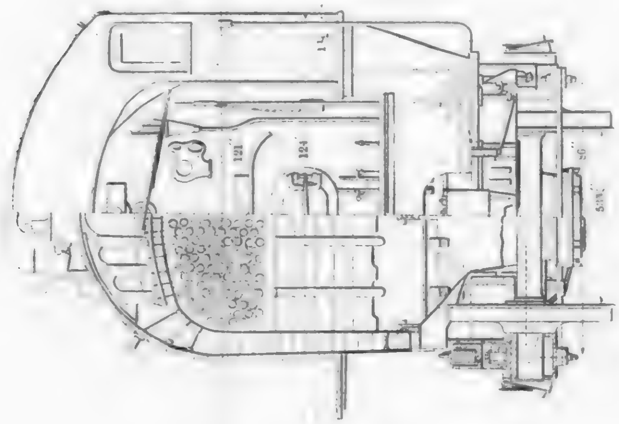
In 1904 fuel for locomotives cost $158,948,886, or 15.8 cents per train mile, against only $74,122,846, or 9.6 cents per train mile, in 1894, the first year the official statistics give figures on the cost of fuel.—*Railway World.*

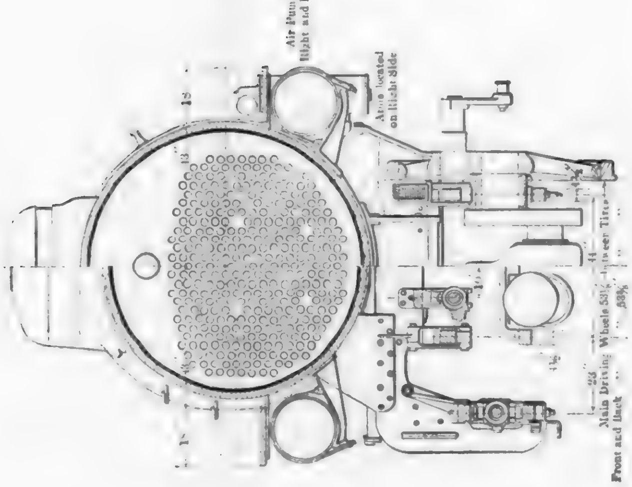
LOCOMOTIVE FOR PENNSYLVANIA STATE COLLEGE.—In response to a request from the school of engineering of the Pennsylvania State College, the Pennsylvania R. R. has sent to the school one of its class D8 locomotives to be used by the students for testing. The board of directors of the railroad have voted to donate this locomotive "when the said college shall have provided a locomotive testing plant," and the college authorities have advised the company that it is expected that the State Legislature at its next session will vote a sufficient sum to completely equip a modern testing plant. When that is done, the engine, which for the present is merely loaned, will become the property of the college.

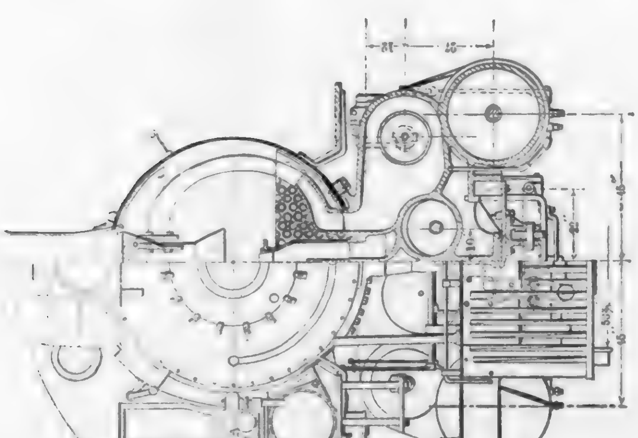
BALANCE COMPOUND PRAIRIE TYPE LOCOMOTIVE WITH INCLINED HIGH PRESSURE CYLINDERS.

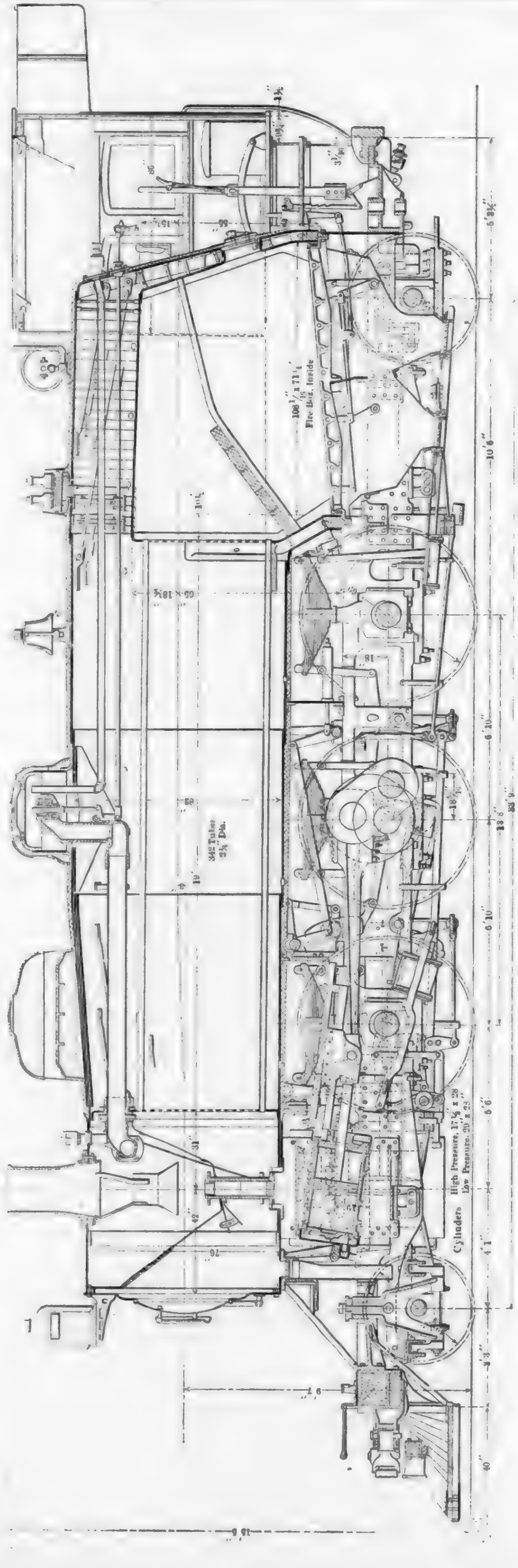
ATCHISON, TOPEKA & SANTA FE RAILWAY.

The Baldwin Locomotive Works are delivering to the Atchison, Topeka & Santa Fe Railway an order of very large and powerful Prairie type locomotives for fast freight service. They are of the Baldwin balanced compound design, and in order to embody this design with this type of locomotive and escape the use of the bifurcated inside main rod for spanning the front axle, the high-pressure cylinders have been raised and inclined sufficiently to allow the inside main rod to pass above the front driving axle. As will be seen by reference to the illustrations this arrangement has not complicated the design









BALDWIN BALANCED COMPOUND PRAIRIE TYPE LOCOMOTIVE, ATCHISON, TOPEKA & SANTA FE RAILWAY.

outside of the cylinders to any appreciable extent. There has been no change made in the cylinder design as far as the balanced principle is concerned, the changes consisting simply in the relocation of the high-pressure cylinders in a higher and inclined position and curving and extending the steam passages to suit. The same type and arrangement of single piston valve, which in this case is operated by the Walschaert gear, that has previously been used on Baldwin balanced compounds, is found here. The inclination of the cylinders has, however, affected the counterbalancing in a peculiar manner, as will be shown in detail.

The Prairie type locomotive for fast freight service, which incidentally includes low-speed heavy passenger service, is becoming quite common in certain sections on Western railroads. During the past few months there have been illustrated in this journal such a design for the Chicago, Burlington & Quincy Railway, where this type has been in very general use for over five years, and in the last issue was shown a similar engine for the Northern Pacific Railway. This one for the Santa Fe, however, is larger and more powerful than either of the previous ones, as can be seen by the accompanying tables of general dimensions, and it also has the further advantage of being a balanced compound.

Owner	A.T.& S.F.	C. B. & Q.	N. P.
Type	2—6—2	2—6—2	2—6—2
Builder	Baldwin.	American	American
Total weight	248,200 lb.	216,000 lb.	209,500 lb.
Weight on drivers	174,700 lb.	159,540 lb.	152,000 lb.
Cylinders	17½ & 29x28 in	22x28 in.	21x28 in.
Diam. of drivers	69 in.	69 in.	63 in.
Steam pressure	225 lbs.	210 lb.	200 lb.
Tractive effort	37,144 lb.	35.060 lb.	33,300 lb.
Total heating surface	4017.8 sq ft	3576 sq. ft.	2340 sq. ft.
Length of tubes	19 ft.	19 ft	13 ft. 3 in.
Weight on Driv. ÷ tractive effort	4.7	4.55	4.55
Trac. Eff. × Diam. Driv. ÷ Heat.Surf.	637.8	677	900
Ttl. Heat. Surf. ÷ Vol. Simp. Cyls.	326	290	209
Reference in AMERICAN ENGINEER	This issue	Aug '06 p 300	Oct '06 p 392

The cylinders are 17½ and 29 x 28 ins., which, with the 225 lbs. steam pressure used and 69-in. drivers, gives a tractive effort of 37,144 lbs. working compound, and can exert a tractive effort of over 50,000 lbs. when operating as a simple in starting. The boiler is large, being 76 ins. at the front tube sheet and increasing in diameter to 82 ins. at the second barrel sheet. It contains 342 tubes 2¼ ins. in diameter, which give a heating surface of over 3,800 square feet. The firebox has a heating surface of 207.3 sq. ft., which makes a total heating surface of the boiler over 4,000 sq. ft., giving about 326 sq. ft. of heating surface per cu. ft. volume of equivalent simple cylinders. The water spaces around the firebox are liberal, and the grate area provides 1 sq. ft. of surface to every 75 sq. ft. of heating surface.

These locomotives weigh 248,200 lbs., of which 174,700 lbs., or over 70 per cent., is on drivers, making them the heaviest Prairie type for either freight or passenger service which we have on our records. The factor of adhesion is 4.7, and the engine weighs 62 lbs. per sq. ft. of total heating surface. The rigid wheel base is 13 ft. 8 ins. The engine was designed for 16-deg. curves.

A very unusual condition is found on these locomotives in that the two main driving-wheel centers are not interchangeable, i.e., there is a different counterbalance weight in each wheel. This, of course, is caused by the 7° inclination of the high-pressure cylinders, which places the cranks of the high and low pressure cylinders on the same side at 187° instead of 180°. The left high-pressure crank is at 83° with the right low-pressure crank, while the right high-pressure crank is at 97° with the left low-pressure crank.

The computation for obtaining the proper weights in each wheel is very interesting.

Through the courtesy of the Baldwin Locomotive Works the following data, compiled by Mr. H. A. F. Campbell, is given in full:

The weights of the rotating parts to be balanced are as follows:

Inside main rod total	650 lbs.
Inside main rod weight to be balanced	424 lbs.
Outside main rod total	725 lbs.
Outside main rod weight to be balanced	418 lbs.
Side rod weight on main pin	572 lbs.
Inside crank pin	137 lbs.
Outside main rod collar and nut	86 lbs.
Outside main side rod pin	93 lbs.
O. S. wrist pin hub	250 lbs.
Eccentric boss + ½ eccentric arm	78 lbs.
Eccentric rod jaw + ½ eccentric rod	45 lbs.
One cheek of crank axle actual	1,425 lbs.
Effect of crank axle cheek at 14 in	712 lbs.
Web concentrated about pin center	873 lbs.
Web remainder	110 lbs.

In order to more easily follow the work, the effect of the different forces has been separately considered. The left I. S. crank is at the forward dead center. All forces and weights act at 14-in. radius and are resolved into their vertical and horizontal components.

Taking movements about C, we have for the right-hand wheel:

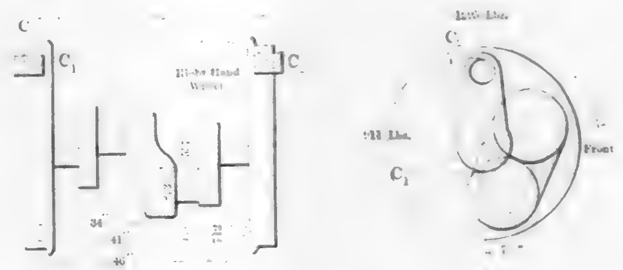


Fig. 1

Downward Forces.	Upward Force.
873 x 34 = 29,680 557 x 41 = 22,837 712 x 46 = 32,750	
C_2 =	+ C_1 $\frac{85,267}{62}$ = 1,396 lbs. acts up
+ 873 + 557 + 712 + C_1	— 1,396
+ 2,142 — 1,396 + C_1	= O
C_1	= 746 lbs. acts up

1,396 sin. 7° = 170 lbs.
1,396 cos. 7° = 1,386 lbs.
746 sin. 7° = 91 lbs.
746 cos. 7° = 741 lbs.
1,386 — 91 = 1,295 lbs 1
741 + 170 = 911 lbs 2

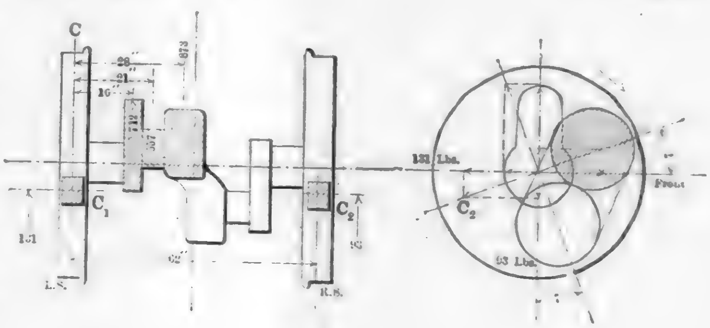


Fig. 2

Downward Forces.	Upward Forces.
C_2 x 62 = 62 C_2	873 x 28 = 24.444 557 x 21 = 11,697 712 x 16 = 11,392 47,533
C_2 =	$\frac{47.533}{62}$ = 766 lbs.
766 C_1	873 557 712 2.142
— 2.142 + 766 + C_1 = O	
C_1 =	1.076 lbs.

766 sin. 7° = 93.3 lbs 3
1,076 sin. 7° = 131 4

The vertical components of these forces are only considered.

Refering to Figure 3.

Effect of 110 lbs. at 14" = $\frac{110 \times 19\frac{1}{4}}{14}$ = 151 lbs.

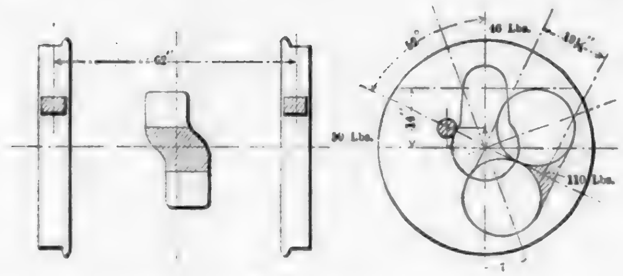


Fig. 3

Has to be balanced by two weights, one in each wheel.

$$\frac{151}{2} = 75 \text{ lbs.}$$

75 x sin. 52° = 59 lbs 5
75 x cos. 52° = 46 lbs 6

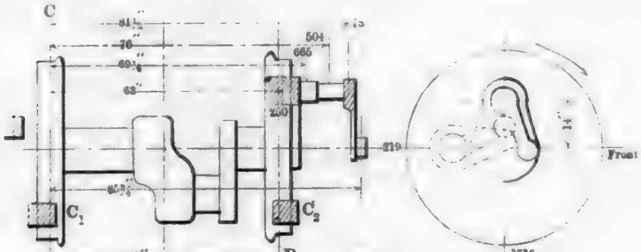


Fig. 4

Downward Force.	Upward Force.
$C_2 \times 62 = 62C_2$	250 x 63 = 15,750 665 x 69¼ = 46,051 504 x 76 = 38,304 78 x 81½ = 6,357 106,462
$C_2 =$	$\frac{106,462}{62}$ = 1,716 lbs. acts down .7
+ 1,716	— 250 — 665 — 504 — 78 — C_1
$C_1 + 1,716$ C_1	— 1,497 = 0 = 219 lbs. acts up..........8

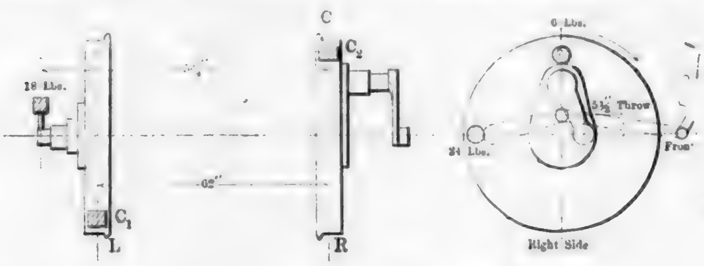


Fig. 5

Effect of weight of eccentric rod boss and ½ eccentric rod at

$$14'' = \frac{45 \times 5\tfrac{1}{2}}{14} = 18 \text{ lbs. nearly}$$

$$C = \frac{85\tfrac{3}{4} \times 18}{62} = 23.51 \text{ lbs.} = 24 \text{ lbs} \quad \ldots\ldots\ldots 9$$

$$+ 23.5 - 18 + C_2 = 0$$
$$C_2 = 5\tfrac{1}{2} \text{ lbs.} = 6 \text{ lbs} \quad \ldots\ldots\ldots 10$$

Combining all horizontal and vertical forces 1—2—3—4—5—6—7—8—9—10 separtely, we have—

Horizontal — 911 + 131 + 59 + 219 + 24 = 1,346 lbs.

Vertical 1,295 — 93 + 46 — 1,716 + 6 = 462 lbs.

Hence the counterbalance weight will be placed at an angle whose tan. = 462 ÷ 1,346, which is 18° 57′ (or 19°) + 90° = 109° back of the right-hand wrist pin. Its magnitude will be the resultant of these two forces.

The resultant = R = $\sqrt{1{,}346^2 + 462^2}$ = 1,423 lbs. (at 14″ radius). The counterbalance weight will act at a radius of about 22 in., and hence equals—

$$\frac{1{,}423 \times 14}{22} = 905 + \text{lbs.}$$

in the right-hand wheel.

Similarily for the left-hand wheel with the right-hand inside crank at the back dead center

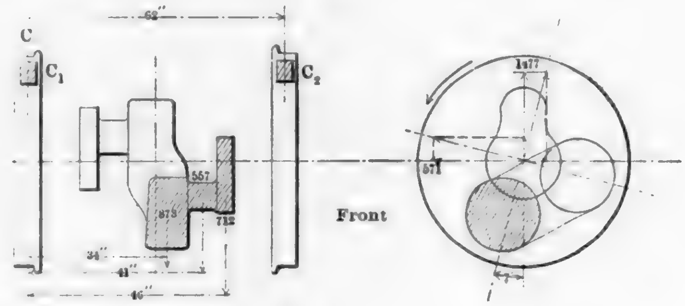


Fig. 6

Downward Forces.	Upward Forces.
873 x 34 = 29,680 557 x 41 = 22,837 712 x 46 = 32,750 85,267	$C_2 \times 62 = 62C_2$
$C_2 =$	$\frac{85,267}{62}$ = 1,396 lbs. acts up
+ 873 + 557 + 712 + C_1	— 1,396
+ 2,142 — 1,396 + C_1	= 0
C_1	= 746 lbs. acts up.

1,396 sin. 7° = 170 lbs.
1,396 cos. 7° = 1,386 lbs.
746 sin. 7° = 91 lbs.
746 cos. 7° = 741 lbs.
1,386 + 91 = 1,477 11
741 — 170 = 571 12

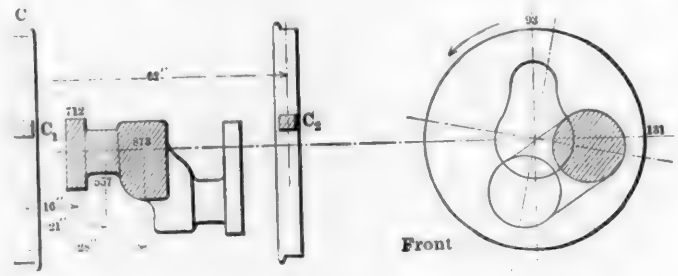


Fig. 7

Downward Forces.	Upward Forces.
$C_2 \times 62 = 62\ C_2$	873 x 28 = 24,444 557 x 21 = 11,697 712 x 16 = 11,392 47,533
C_2	$\frac{47,533}{62}$ = 766 lbs.
+ 766 C_1	— 873 — 557 — 712
— 2,142 + 766 + C_1	= 0
C_1	= 1,076 lbs.

766 sin. 7° = 933 lbs 13
1,076 sin. 7° = 131 lbs 14

The vertical components of these forces are only considered,

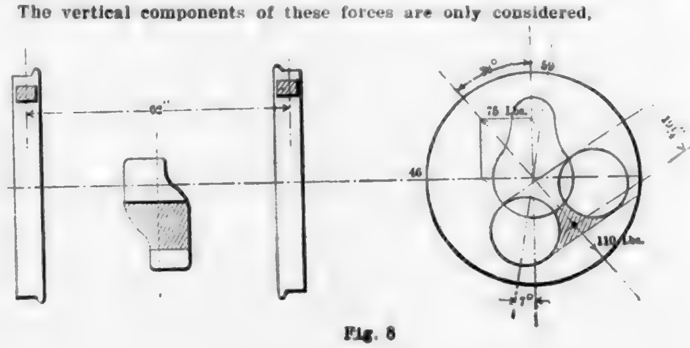


Fig. 8

Referring to Figure 8

$$\frac{110 \times 19\frac{1}{4}}{14} = 151 \text{ lbs. at 14 inches radius.}$$

This has to be balanced by two weights, one in each wheel.

$$\frac{151}{2} = 75 \text{ lbs.}$$

75 x sin. 38° = 59 lbs.	15
75 x cos. 38° = 46 lbs.	15

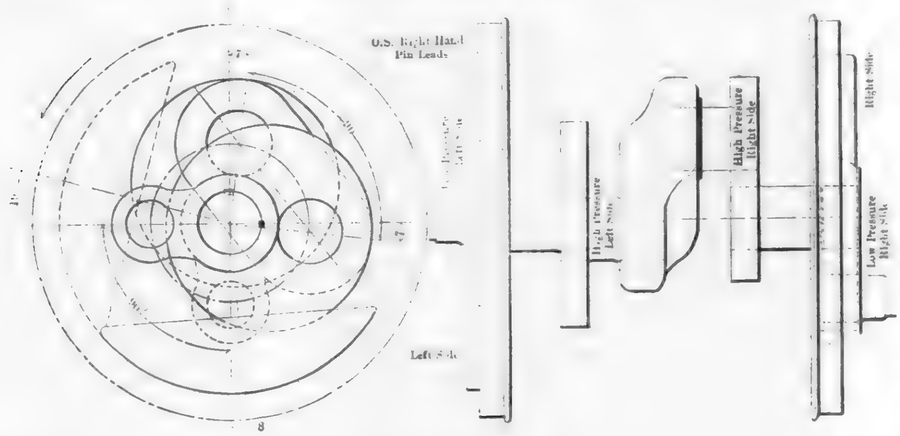
The weights of the outside rods, pins and eccentric boss and rod are the same as for the right-hand wheel (see Figs. 4 and 5), except that the eccentric boss and rod act in the opposite directions.

Thus combining as before we find the horizontal forces to be $571 - 131 + 46 + 219 - 24 = 681$ lbs., and the vertical forces equal $1{,}716 + 6 - 1{,}477 - 93 - 59 = 93$ lbs.

Hence the counterbalance weights will be placed at an angle whose tan. $= 93 \div 681$, which is practically 8 deg. This weight will have to be such as to balance the resultant of these two forces acting at a 14-in. radius. This resultant $R = \sqrt{681^2 + 93^2} = 687$ lbs.

The counterbalance weight will act at a radius of about 22 ins., and hence equals about 440 lbs. placed in the left-hand wheel.

These weights counterbalance the rotating parts only, as is evident from a study of the above data, and by a careful arrangement in the design, the reciprocating weights are so nearly alike between the high and low-pressure cylinders on the same side of the engine as to almost exactly balance themselves, and hence are disregarded altogether. The high-pressure piston is made solid and heavy, and the low-pressure piston is made as light as possible. While, of course, there is a slight difference in other parts of the high and low-pressure side, it is not sufficient to exceed the amount which is allowed by the master mechanic's rule to remain unbalanced.



The photograph, giving a general view and more details of this locomotive in connection with the cylinders and valve gear, will be given in the next issue. The general dimensions, weights and ratios are as follows:

FOUR-CYLINDER BALANCED COMPOUND FREIGHT LOCOMOTIVE.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Fast Freight
Fuel	Bit. coal
Tractive effort comp	37,144 lbs.
Weight in working order	248,200 lbs.
Weight on drivers	174,700 lbs.
Weight on leading truck	31,300 lbs.
Weight on trailing truck	42,200 lbs.
Weight of engine and tender in working order	418,000 lbs.
Wheel base, driving	13 ft. 8 in.
Wheel base, total	33 ft. 9 in.
Wheel base, engine and tender	64 ft. 7½ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.7
Total weight ÷ tractive effort	6.7
Tractive effort × diam. drivers ÷ heating surface	637.8
Total heating surface ÷ grate area	75
Firebox heating surface ÷ total heating surface %	5.2
Weight on drivers ÷ total heating surface	43.5
Total weight ÷ total heating surface	62
Volume equiv. simple cylinders	12.3 cu. ft.
Total heating surface ÷ vol. cylinders	326
Grate area ÷ vol. cylinders	4.35
CYLINDERS.	
Kind	Bal. Comp.
Diameter and stroke	17½ & 29 x 28 in.
Kind of valve	Piston
WHEELS.	
Driving, diameter over tires	69 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	11 x 10½ in.
Driving journals, others, diameter and length	10 x 12 in.
Engine truck wheels, diameter	42¼ in.
Engine truck, journals	6½ x 12 in.
Trailing truck wheels, diameter	50 in.
Trailing truck, journals	8 x 14 in.
BOILER.	
Style	E. W. T.
Working pressure	225 lbs.
Outside diameter of first ring	76 in.
Firebox, length and width	108 1/16 x 71 1/4 in.
Firebox plates, thickness	3/8 & 9/16 in.
Firebox, water space	F4½-8 & B4 in.
Tubes, number and outside diameter	342 2¼ in.
Tubes, length	19 ft.
Heating surface, tubes	3,810.5 sq. ft.
Heating surface, firebox	207.3 sq. ft.
Heating surface, total	4,017.8 sq. ft.
Grate area	53.5 sq. ft.
Smokestack, height above rail	15 ft. 5 in.
Center of boiler above rail	9 ft. 7 in.
TENDER.	
Wheels, diameter	34¼ in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9,000 gals.
Coal capacity	12 tons

COLLEGE MEN IN RAILROAD SERVICE.—College men are taken with a grain of salt, not because they are inferior, for, on the contrary, they may be good men of sound minds, but they are pretty much like that useful article known as a frying pan without a handle, wherein it is possible to melt good fat and prepare a solid meal, but without the handle it is difficult to make prompt and practical use of it, and burnt fingers are the result. I believe that the average college man will not at first find the railroad service a very attractive field, nor will the railroad official consider him a very attractive "find," until both understand each other better. The railroad man should realize that the college man has, or ought to have, a better developed mind and body and be trained to co-operate with others in obtaining results, and, secondly, the college man must appreciate the necessity of getting down to business.—*A. J. County, Asst. to Third Vice-Prest. P. R. R. Co., in "Railroad Men."*

NAMING LOCOMOTIVES.—The following note, taken from a recent issue of *The Locomotive Magazine*, may recall to the minds of some of our readers the time when locomotives were not quite as numerous in this country as at present. It is surprising to learn, however, that the road in question has over 850 locomotives: "The following is the list of names allotted to the new Atlantic type locomotives for the North British Railway, illustrated and described in our last issue: 'Aberdonian,' 'Abbottsford,' 'Bon Accord,' 'Borderer,' 'Cumberland,' 'Dunedin,' 'Dundonian,' 'Hazeldean,' 'Midlothian,' 'St. Mungo,' 'Teviotdale,' 'Thane of Fife,' 'Tweeddale' and 'Waverley.'"

CONGESTION IN THE PATENT OFFICE.—Mr. Fred W. Barnaclo, in a recent issue of the New York *Commercial*, calls attention to the serious situation confronting the patent office at Washington. On the first of this year the patent office had 17,353 applications waiting for action. The *Official Gazette* for September 25 shows that this number has now increased to 23,468. The number of applications received weekly varies from 800 to 1,200, and the average weekly excess over the number issued during the past nine months has been 170. The force of examiners allowed the patent office is not large enough to handle the great number of applications now coming in and the office is getting further and further behind in its work. At the present time some departments are back from six months to a year—that is to say, this time must elapse after application is made before the applicant receives notice that his case is under consideration.

COMMUNICATIONS

M. M. AND M. C. B. ASSOCIATION.

To the Editor:

I am glad to read what is said editorially in the September number suggesting improvements in the methods of conducting the Master Mechanics' Association meetings and think that the points are well taken. I believe that there is some feeling that we are not giving the proper attention to the subjects which are presented. An additional criticism that I would make is that the program is not carried out according to schedule, so that persons desiring to be present during the discussion of a particular topic may find on arrival that that topic has been passed two hours in advance without discussion and dropped. Such occurred during the last session of the late convention.

BOSTON, Mass. C. B. SMITH.

THE SURCHARGE PROBLEM.

To the Editor:

At the bottom of page 376 in the October issue, in the article entitled "The Surcharge Problem," by Mr. C. J. Morrison, is given a detailed example of the computation of cost of manufacture of a given article. Then follows the statement: "We now know *beyond the shadow of a doubt* whether to buy or manufacture this article, *as the decision hinges on whether the price is below or above* $2.60." The solution of the problem does not seem to me to be quite so simple.

Let it be supposed that the market price of the given article is $2.50. According to the figures given, it would be more economical to discontinue its manufacture and purchase on the market. If this was done, what would become of the 40 per cent. surcharge? I do not believe that in this particular case it would be reduced more than 10 per cent. The remaining 45 cents would simply be loaded on to the other work carried on in the shops, unless the shop superintendent was able to manufacture in place of the article in question some other article whose shop cost, computed in this way, would, when compared with the market price, make a more favorable showing.

I do not believe, when once a railroad shop is built and equipped and its organization established, that its surcharges either "money" or "book" are likely to be affected very much by the manufacture or discontinuance of manufacture of any single article.

In the particular example given Class I. would not likely be affected at all, Class II. in Division D only, and Classes III. and IV. reduced very little, and, unless some other article was substituted for manufacture to keep the shop working to the limit of its capacity, probably 90 per cent. of this 40 per cent. surcharge would have to be paid just the same in addition to the market price. Yours truly,

THEO. F. H. ZEALAND.

Illinois Central, Chicago.

To the Editor:

The article on the surcharge problem in your last number is a beacon ray of light on a very foggy situation. The analysis given seems to me to be very clear and simple to follow, and worthy of careful attention.

The customary treatment of this subject is contented with a hit or miss, flat blanket rate, evolved from the accounting department. Machines known to be uneconomical are shipped around from one shop or division to another, unable to find the scrap pile as long as they will possibly turn. It is very hard to get cash appropriations for their replacement, without the aid of such a surcharge study. I have in mind a certain driving-wheel lathe of the vintage of 1860, which was condemned as useless, and shipped away from a four-pit shop in the eighties. Apparently it went on the extra list because, some fifteen years later, after suffering the annoyance of sending all wheels 170 miles for tire turning, a new lathe was requisitioned, the old veteran reappeared, and the shop was compelled to reinstall it or do without.

A more widespread knowledge of cost would seem to be advisable. It is general practice to-day to show the cost of rough parts upon the tag at the storehouse bin, but neither the workman nor his foreman have an idea of the actual cost of the article by the time it is applied to the locomotive.

It is even worse in the draughting room. The railroad designer ordinarily contents himself by getting out something that will do the work and not weigh too much. The successful industrial designer, however, must be an expert mechanic as well, and acquainted with the detail costs of manufacture in order to produce the cheapest possible design.

The text of the entire article is found in the last paragraph, a text which has been preached so often to railroad officials. That it is possible to save money by spending money appears to be a more difficult mental process for the average railroad man than for his industrial neighbor. Very truly yours,

New York. PAUL R. BROOKS.

To the Editor:

Mr. Morrison's article in your October issue strikes what I believe to be the weakest point in the mechanical departments of our railroads to-day. All of them are manufactors to a greater or less extent, and in most cases, are undoubtedly carrying on this work without applying the most simple principles of industrial accounting, and without any real knowledge of whether that part of the shop output is a paying proposition in its details or not.

The surcharge as Mr. Morrison clearly shows, is a very large factor in the cost of any manufactured article, and a flat rate or percentage added to the labor and material charge, in any particular case, will not give a true value. This will actually be found to vary by wide limits on both sides of the figure obtained in that way.

It seems to me that a careful investigation of this subject in the railroad shops will be of benefit in more ways than in giving exact costs of manufactured articles. It will undoubtedly, if the charges carried by each machine in the shop are put in a clear tabular form, tend to influence a foreman to keep his shop evenly balanced, and keep all his machines in operation at their maximum capacity. It will give a correct index of each foreman's managing ability, as compared with other foremen. It will settle the question of purchasing new and better machinery without any doubt. It will tell whether it will pay to tear out the present steam power plant which transmits power through long lines of shafting, cables and steam pipes, and install an electric drive. In fact, the uses to which detailed figures on the subject as outlined in your article can be put, are almost without number, and I hope to see you give us more on the subject.

I would suggest that an article showing the methods used in arriving at the proper charge for different machines, possibly put in algebraic form, would no doubt, be much appreciated by many of your readers, as well as by myself.

Yours truly,

F. B. B.

To the Editor:

Referring to the article on "The Surcharge Problem" by Mr. C. J. Morrison on page 376 of your October issue, and also to your editorial on page 391. The ideas are very good but I am afraid that their practical application would present many difficulties on the average railroad. For instance, the method of keeping accounts on the road with which I am connected is such that it is very questionable whether we would be able to obtain accurate information concerning the various items which go to make up these surcharges. The arguments presented, however, are certainly good and I for one would like to have you publish more detailed information concerning the method of applying and using such a system if, as apparently suggested, it is in actual use in a railroad repair shop.

It is true that many manufacturers are accustomed to study very closely this matter of surcharges, but their work is entirely different from that which is done in a railroad repair shop. Machines or other work are put through the shop in quantities and there is practically no repair work to handle. The manufacturing concerns which use such a system, and with which I am acquainted, are very much smaller and the organization is not nearly as complicated as that of a railroad shop. Under these conditions it is comparatively easy to calculate the surcharge on the various machines, but the varied amount of work which may be handled on a single machine in a railroad repair shop is such that it would seem that only a very rough estimate can be made as to the amount of the surcharges on any one man or machine for a particular piece of work. On machines where work of only one kind is done the difficulties would not be as great. Could not Mr. Morrison present some figures as to the increase in the force which would be required to instal a system of this kind in a shop which has to take care of 300 locomotives?

SHOP SUPERINTENDENT.

THE DRAFT GEAR SITUATION.

To the Editor:

During the past year or two the railroad club proceedings, technical journals and railway mechanical association proceedings have contained a number of articles concerning the advantages of friction draft gears as compared to spring gears. However, although the friction gears have in many instances been in service for a number of years, their advantages are usually stated in general terms, and have not been reduced to a dollar-and-cent basis. In spite of the many good things which have been said concerning this type of gear, it would appear from a study of the equipment notes in the various journals that the percentage of cars which are being equipped with friction gears is very small compared to the number which are being built. If the friction gear has so many advantages, why is it that it is not more generally used, especially as in many instances we find that the spring rigging costs practically as much as the friction rigging.

The very elaborate tests which were reported by the committee on draft gears at the 1902 convention of the Master Car Builders' Association showed conclusively that, as far as the drop tests and the static tests were concerned, the friction rigging was far superior to the spring rigging. Unfortunately, neither one of these two tests fulfill the conditions which are met in service, and therefore they have not carried the weight that they would if they had been made under conditions more nearly approximating those met in service. With the great increase in the capacity and size of locomotives, cars and trains the matter of using the best draft gear becomes an exceedingly important one, and it would seem that this question should be decided as soon as possible, since the friction gears have apparently passed the experimental stage. It is understood that several roads have made tests of the different types of draft gears, but, if so, very little, if any, of this information has been given out. Would it not be possible for the Master Car Builders' Association to build a testing machine or else conduct service tests which would show the exact action of the different gears under service conditions? The problem of building a testing machine to meet those conditions ought not to be a very serious one, or if this course is not feasible it ought to be possible to have extensive service tests made on some of the roads under the jurisdiction of a Master Car Builders' committee. Doubtless the manufacturers of both the spring and friction gears would look with favor upon such tests, if carefully made, in order to show conclusively the advantages of the two types of gear, and the results would probably be such as to make possible a considerable financial saving to the railroads.

Minneapolis, Minn. A. RAIL ROADER.

HOW CAN THE CO-OPERATION OF THE ORDINARY MECHANIC BE OBTAINED IN INCREASING SHOP OUT-PUT?

To the Editor:

This is a question of great importance to the mechanical department, and it is more in the line of receiving suggestions or criticisms from others than from the value of any ideas presented in this article that it is written.

I think that no one will dispute that 99 per cent. of the actual work, either in repairing old or building new engines, is done by the ordinary mechanic who has learned his trade through actual experience in the shop, combined in many instances with self-education along technical lines by the reading of books, technical journals, etc. This being the case, there is a question whether the upholding of the technical graduate in the form of special apprenticeship, with the understanding that as soon as possible he is to secure whatever plums there are on the tree, has not had a deterrent effect on the best of the rank and file, and has caused them to take less interest in their work and discouraged them in bringing forward ideas that would better prevailing methods, thus increasing the output.

It is said that you cannot keep the man down who is bound to rise, and while this may be true, still it will usually be found that those who have attained great success through their own efforts have received encouragement in their ascent, and the prospect of further promotion has been held out to them from time to time.

Other reasons why ordinary workmen refrain from advancing suggestions for the improvement or increase of production are the way they are received, they being sometimes told by persons in authority that others are paid for doing that kind of work, or, in other words, that they had better stick to their hammer and chisel and other people would furnish the brains. That this is at all universal is by no means claimed, but it is not entirely unknown. Again, how often it is that a workman advances an idea that is adopted and proves successful, and it is then spoken of and shown by his superiors as something we have gotten up, with a special emphasis on the *WE*. In addition the ambitious, practical man who does things has also to meet the opposition and sometimes the derision of his fellows, especially of those who have little ability and less ambition.

Another point worth looking into is the bad effect produced by the equal wage rate that is in force in nearly all shops having agreements with labor organizations. In almost every case the minimum rate is also the maximum, and this results in putting the poorest man in the shop on an equal basis with the best one as regards wages paid. The result is plainly to be seen when you have the best and poorest man in the shop on opposite sides of an engine doing the same class of work. It is open to question, if it would not be economy for the railroads of their own volition to adopt a higher rate for the exceptionally good men, as it would be something to strive for, rather than to have all ambition destroyed by one universal flat rate.

Some one will suggest piecework as a remedy, but can it be denied that the antagonism to it by all labor organizations is due to injustice from it in the past, and is there any guarantee that the world has grown so good that the same conditions will not exist in the future?

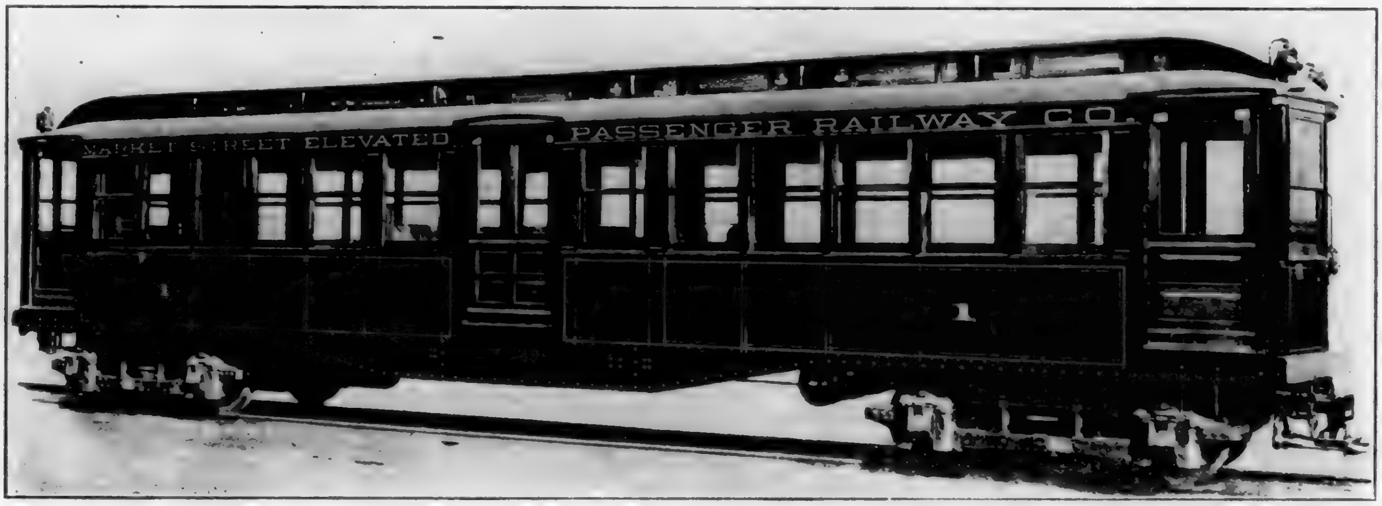
What, then, are the remedies? The following are suggested: The capabilities of men to be closely followed, and the men with the necessary qualifications to be promoted as vacancies occur. That the advancement of ideas and the giving out by the men of the best that is in them be more encouraged, and, if an idea is adopted and is a pronounced success that some return, either in the shape of money or some other consideration, be made to the inventor. Teaching the individual and organizations that cheapening production does not cheapen labor, but enlarges the field of use and benefits the world at large. The treatment of all employees with courtesy and friendliness. Absolute truthfulness in all dealings and the rigid keeping of all promises and agreements. The encouragement of study, especially of technical books and magazines, by all and most strongly by apprentices; to this the study of mechanical drawing should be added where possible. Fostering the spirit through the shop that we desire to be in the van and not in the rear, no matter how small the shop. Cleanliness in the shop is necessary, and moral tone should be encouraged, as the man is to a great extent influenced by his surroundings. A man cannot be expected to take an interest in his work if he is falling over scrap in the machine shop, or working on the top of an ash heap, or in a pool of water in the roundhouse. Carefully note the result of substituting the men who are considered best able to fill the position in place of absent foremen, without tying their hands. These ideas are advanced as having a tendency in the right direction.

In conclusion, would say that the remuneration for ideas is considered to apply to the ordinary workingman only, as it is considered that it is the foreman's duty to be thinking along this line and of doing everything in his power to promote his employer's interest; if he is not doing so he is unworthy of the position he occupies. What has been said regarding technical graduates is with no prejudice against them, as many of them have worked under my supervision and are among my best friends, but while no one can question that the thoroughly practical man with a thorough technical education is the best man to be procured, it is doubtful if the ordinary technical graduate is of any more value in railroad work, outside of testing operations, than the better class of ordinary apprentice, and if he wishes to attain prominence in the mechanical department he should willingly meet the ordinary apprentice on an equal footing, and his superior education will give him so much of an advantage that, other talents being equal, he should have no fear of results.

Winona, Minn. CHARLES COLEMAN,
General Foreman, C. & N. W. Ry.

The First Electrical Train to enter the Grand Central Station, New York, ran from High Bridge, a distance of about 7½ miles, into the station and return on September 30. Mr. W. J. Wilgus, vice-president of the New York Central, acted as motorman, and in the train were a number of officials of the road and their guests.

The Strength of a Grindstone appears, from recent tests, to vary widely with the degree of its wetness or dryness: stones that are dry showing tensile strengths of from 146 to 186 lbs. per sq. in, but, after soaking over night, breaking under stresses of 80 to 116 lbs. per sq. in.—*Engineering Record.*



GENERAL VIEW OF STEEL PASSENGER CAR.

STEEL PASSENGER CAR WITH SIDE DOORS.

The Pressed Steel Car Company has recently built 40 steel passenger cars with side doors for the Market Street elevated and subway line of the Philadelphia Rapid Transit Company. The framing throughout, as well as the side sheathing, is of steel construction. The underframing consists of deep fish-belly side sills, with cross bearers and connections in girder form. The general dimensions are as follows:

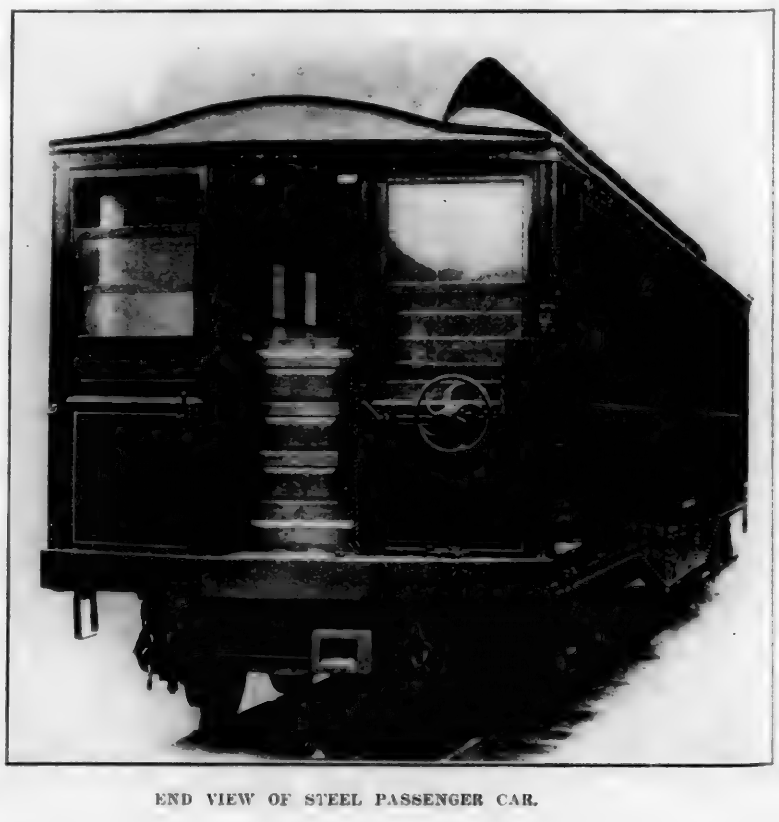
Length over platform (over all)	49 ft. 7¼ ins.
Length over door posts	40 ft. 6¼ ins.
Length inside of car (end lining)	39 ft. 6¼ ins.
Width of car outside of side sheets	8 ft. 7 ins.
Width of car inside	7 ft. 7¾ ins.
Height from rail to top of floor	3 ft. 10 ins.
Height from floor to ceiling (center)	8 ft. 6½ ins.
Height from rail to top of car	12 ft. 7 ins.
Opening for vestibule side door (between door posts)	2 ft. 9 ins.
Width of end door opening	3 ft. 2½ ins.
Width of center door opening (side)	3 ft. 4 ins.
Distance from center to center of trucks	34 ft. 6 ins.
Width over eaves-upper deck	5 ft. 6¾ ins.
Width over eaves-lower deck	8 ft. 8⅝ ins.
Width of vestibule end door opening	2 ft.

The 12 carlins are of 1½ x 1½-in. steel. The underframe is covered with corrugated steel sheets and monolithic flooring composition. The roof is constructed of tongue and groove poplar, ½ in. thick, covered with eight-ounce cotton duck. The side doors, both at the ends and at the center, are arranged for opening and closing from either end of the car by means of pneumatic devices. The doors are of mahogany, with the lower half paneled, and one light of ¼-in. plate glass in the upper half. The interior finish is of straight-grained mahogany. There is a motorman's cab at each end of the car. The seating arrangement consists of four longitudinal seats for nine persons each and eight cross seats in the center of the car for two persons each. Of the 24 side windows 18 have the upper sash movable and the lower sash stationary. The cars are equipped for heating and lighting by electricity.

These are among the first cars built by the new passenger car works of the Pressed Steel Car Company. The first car was completed in the early spring for the United Railways of San Francisco, and was an all-steel car of the "California" type. Following this three combination steel and wood passenger cars were built for the Southern Railway. These were illustrated and described on page 260 of our July issue. Following these were the 40 cars as described above for the Philadelphia Rapid Transit Company.

Speed of Emery Wheels.—Ordinarily, emery wheels give best results when run at a peripheral speed of 5,500 ft. per minute. If run too fast, they will heat the work and glaze, and, if run too slowly, will wear away rapidly and do but little work.

Malleable Iron, Physical Properties.—Designers in general, in making use of malleable iron castings, proceed without definite knowledge as to the physical properties of this material, so far, at least, as its tensile strength and elongation are concerned. Mr. G. A. Ackerlind read before the Scandinavian Technical Society recently a paper in which he gave some definite information as to the properties of malleable cast iron, as made in that country. This information is doubtless applicable to American irons as well. He states that the tensile strength for this material varies between 40,000 lbs. and 50,000 lbs. per sq. in. It has elongation varying from 1 to 6 per cent., with a reduction of area of ¾ to 3 per cent. The ordinary grade of cast iron, having a tensile strength from 20,000 to 30,000 lbs. per sq. in., is therefore only about half as strong as malleable cast iron; its compressive strength, however, is much greater. Malleable cast iron shrinks more in the mold than cast iron, but during the process of annealing a slight swelling takes place. If malleable castings have to be straightened by hammering, nothing is gained by heating them, the normal temperature of the surrounding air being satisfactory for this purpose.—*Machinery.*



END VIEW OF STEEL PASSENGER CAR.

THE ECONOMICAL WORKING OF LOCOMOTIVES.

Mr. William Ernest Dalby, in a paper (No. 3,577) presented before the Institution of Civil Engineers, investigates the economical working and design of simple locomotives with reference to certain considerations which, although known in a general way, have not, in his opinion, received the attention they deserve.

The results of his investigation and analysis are summed up very nicely in the following conclusions:

1. The mean pressure in a locomotive cylinder, with boiler pressure and cut-off constant, and the regulator wide open, decreases as the speed increases.

2. The law connecting the mean pressure with the piston speed is approximately linear and of the form

$$p = c - bv,$$

where c and b are constants found by experiment, and p is the mean pressure in pounds per square inch corresponding to a piston speed of v feet per minute.

3. In consequence of this dropping of the mean pressure with the speed, there is one piston speed at which the indicator horse power is a maximum, and this speed is given by

$$v = \frac{c}{2b},$$

the corresponding value of the mean pressure being

$$p = \frac{c}{2},$$

and the corresponding value of the maximum horse power

$$\text{I.HP.}_{max} = \frac{c^2 a}{132{,}000\, b}.$$

4. In the absence of a series of experiments connecting p and v, c may be taken to represent the mean pressure for the stated cut-off and initial pressure, neglecting all wire-drawing effects, and b may then be found from the equation

$$b = \frac{c - p}{v},$$

p and v being the corresponding values of the mean pressure and piston speed found from an indicator-diagram taken at a piston speed of about 800 ft. per minute.

5. In this way a series of values of c and b may be easily found, and may be used to determine approximately the best piston speed for each particular cut-off.

6. The best piston speed for the maximum drawbar horse power is less than that for the maximum indicator horse power, and can be readily found when the efficiency of the engine itself is known.

7. The drop in pressure could possibly be reduced materially by designing short, straight ports of ample area and avoiding all crooked passageways for the steam.

Application of Results to Solution of Problems.—The foregoing results may be readily applied in the solution of many useful problems. For example, let it be required to find the speed on the level corresponding to the maximum drawbar horse power for a stated cut-off and boiler pressure.

The diameter of the driving wheel must be given, in order to express the train speed in terms of the mean piston speed, and also some estimate must be made of the engine resistance. The latter, reckoned up to the drawbar, may be expressed as a function of the load, or of the speed, or of both the load and the speed, but for the purpose in view it may be taken as constant and equal to 30 lbs. per ton at all speeds.

Let R denote the constant engine resistance in lbs. per ton,
- W the weight of the engine and tender,
- s the stroke in inches,
- D the diameter of the driving wheel in inches,
- v the piston speed in feet per minute,
- V the train speed in feet per minute,
- a the joint area of the two cylinders in sq. ins.

Then the rate at which work is done against engine resistance is

$$WRV \text{ foot-lbs. per minute.}$$

But
$$V = \frac{v\pi D}{2s},$$

therefore the rate of working against the engine resistance is

$$\frac{WRD\pi v}{2s} = Qv,$$

where
$$Q = \frac{WR\pi D}{2s}$$

and the rate of working in the cylinders is

$$pva, \text{ where } p = c - bv.$$

Therefore the rate of working at the drawbar is given by

$$U = (c - bv)\, av - vQ \text{ foot-pounds per minute}$$

And this is a maximum when

$$\frac{dU}{dv} = 0.$$

That is, when
$$v = \frac{ac - Q}{2ab}$$

The problem may be extended to find the speed at which the drawbar horse power is a maximum, it being given, in addition to the data of the previous problem, that the train is to ascend a gradient of 1 in G.

The additional engine resistance against the gradient is $R_1 = \frac{2{,}240}{G}$ lbs. per ton, so that the total engine resistance against the gradient is $\frac{W\, 2{,}240}{G}$. The rate of working against this resistance is $\frac{2{,}240\, WV}{G}$ foot lbs. per minute; and expressing V in terms of the mean piston speed this becomes

$$\frac{2{,}240\, Wv\pi D}{2sG} = vQ_1$$

where
$$Q_1 = \frac{2{,}240\, W\pi D}{2Gs}.$$

The rate of working at the drawbar is now

$$pva - (Q + Q_1)\, v,$$

and from this, the speed for a maximum, found as in the previous example, is

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The more practical problem of calculating approximately the maximum load which an engine will take up a given gradient at a stated speed, cut-off and boiler pressure can be solved without difficulty if the engine and train resistances are known.

GRINDING HIGH-SPEED STEEL TOOLS.—High-speed steel tools can be ruined very easily in the machine shop by grinding them on the emery wheel until they get hot and then plunging them into water. After doing this, the cutting edge of the tools will be found full of cracks. One machine foreman complained that the tool dresser was cracking the tools in hardening, but a careful investigation showed that the tools had been cracked by grinding in this way. The man was instructed how to grind the high-speed tools properly and that put an end to the trouble from cracks in the tools.—*J. G. Jordan in I. R. M. B. Convention.*

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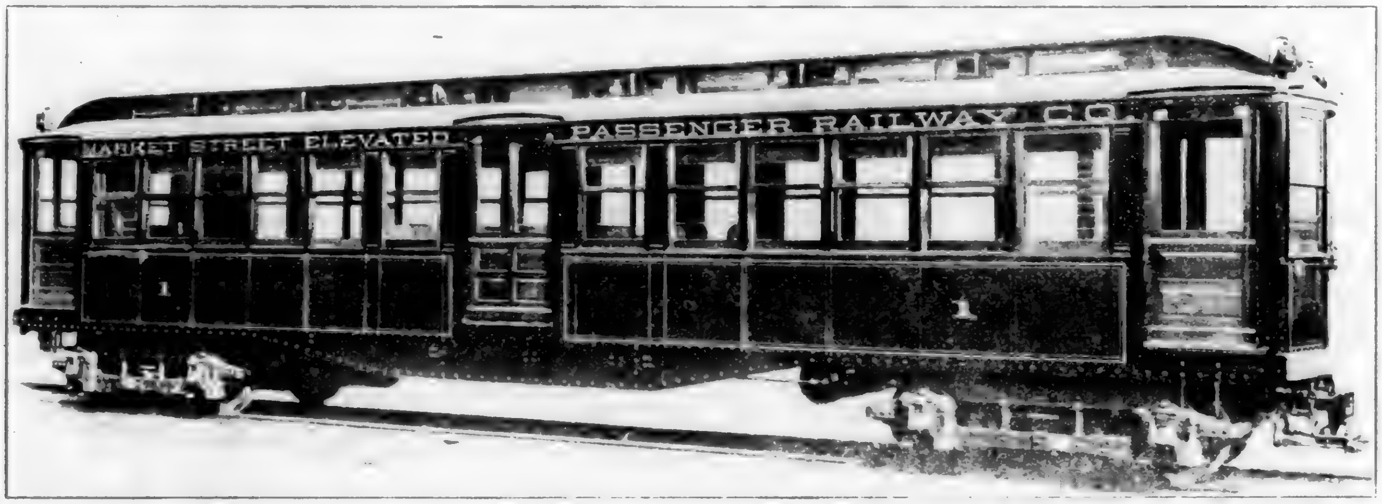


GENERAL VIEW OF STEEL PASSENGER CAR.

STEEL PASSENGER CAR WITH SIDE DOORS.

The Pressed Steel Car Company has recently built 40 steel passenger cars with side doors for the Market Street elevated and subway line of the Philadelphia Rapid Transit Company. The framing throughout, as well as the side sheathing, is of steel construction. The underframing consists of deep fish-belly side sills, with cross bearers and connections in girder form. The general dimensions are as follows:

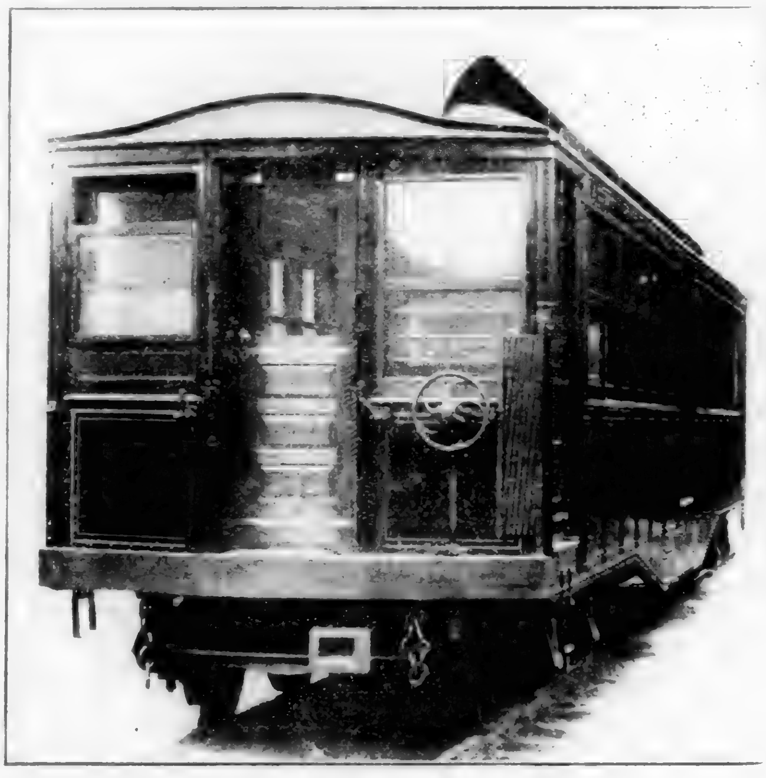
Length over platform (over all)	[illegible]
Length over door posts	40 ft. 6¼ ins.
Length inside of car (end lining)	39 ft. 6¼ ins.
Width of car outside of side sheets	8 ft. 7 ins.
Width of car inside	7 ft. 7¾ ins.
Height from rail to top of floor	3 ft. 10 ins.
Height from floor to ceiling (center)	8 ft. 6½ ins.
Height from rail to top of car	12 ft. 7 ins.
Opening for vestibule side door (between door posts)	2 ft. 9 ins.
Width of end door opening	3 ft. 2½ ins.
Width of center door opening (side)	3 ft. 4 ins.
Distance from center to center of trucks	34 ft. 6 ins.
Width over eaves-upper deck	5 ft. 6¾ ins.
Width over eaves-lower deck	8 ft. 8⅝ ins.
Width of vestibule end door opening	2 ft.

The 12 carlins are of 1½ x 1½-in. steel. The underframe is covered with corrugated steel sheets and monolithic flooring composition. The roof is constructed of tongue and groove poplar, ½ in. thick, covered with eight-ounce cotton duck. The side doors, both at the ends and at the center, are arranged for opening and closing from either end of the car by means of pneumatic devices. The doors are of mahogany, with the lower half paneled, and one light of ¼-in plate glass in the upper half. The interior finish is of straight grained mahogany. There is a motorman's cab at each end of the car. The seating arrangement consists of four longitudinal seats for nine persons each and eight cross seats in the center of the car for two persons each. Of the 24 side windows 18 have the upper sash movable and the lower sash stationary. The cars are equipped for heating and lighting by electricity.

These are among the first cars built by the new passenger car works of the Pressed Steel Car Company. The first car was completed in the early spring for the United Railways of San Francisco, and was an all-steel car of the "California" type. Following this three combination steel and wood passenger cars were built for the Southern Railway. These were illustrated and described on page 260 of our July issue. Following these were the 40 cars as described above for the Philadelphia Rapid Transit Company.

Speed of Emery Wheels.—Ordinarily, emery wheels give best results when run at a peripheral speed of 5,500 ft. per minute. If run too fast, they will heat the work and glaze, and, if run too slowly, will wear away rapidly and do but little work.

Malleable Iron, Physical Properties.—Designers in general, in making use of malleable iron castings, proceed without definite knowledge as to the physical properties of this material, so far, at least, as its tensile strength and elongation are concerned. Mr. G. A. Ackerlind read before the Scandinavian Technical Society recently a paper in which he gave some definite information as to the properties of malleable cast iron, as made in that country. This information is doubtless applicable to American irons as well. He states that the tensile strength for this material varies between 40,000 lbs. and 50,000 lbs. per sq. in. It has elongation varying from 1 to 6 per cent., with a reduction of area of ¾ to 3 per cent. The ordinary grade of cast iron, having a tensile strength from 20,000 to 30,000 lbs. per sq. in., is therefore only about half as strong as malleable cast iron; its compressive strength, however, is much greater. Malleable cast iron shrinks more in the mold than cast iron, but during the process of annealing a slight swelling takes place. If malleable castings have to be straightened by hammering, nothing is gained by heating them, the normal temperature of the surrounding air being satisfactory for this purpose.—*Machinery.*



END VIEW OF STEEL PASSENGER CAR.

THE ECONOMICAL WORKING OF LOCOMOTIVES.

Mr. William Ernest Dalby, in a paper (No. 3,577) presented before the Institution of Civil Engineers, investigates the economical working and design of simple locomotives with reference to certain considerations which, although known in a general way, have not, in his opinion, received the attention they deserve.

The results of his investigation and analysis are summed up very nicely in the following conclusions:

1. The mean pressure in a locomotive cylinder, with boiler pressure and cut-off constant, and the regulator wide open, decreases as the speed increases.

2. The law connecting the mean pressure with the piston speed is approximately linear and of the form

$$p = c - bv,$$

where c and b are constants found by experiment, and p is the mean pressure in pounds per square inch corresponding to a piston speed of v feet per minute.

3. In consequence of this dropping of the mean pressure with the speed, there is one piston speed at which the indicator horse power is a maximum, and this speed is given by

$$v = \frac{c}{2b}$$

the corresponding value of the mean pressure being

$$p = \frac{c}{2},$$

and the corresponding value of the maximum horse power

$$\text{I.H.P.}_{max} = \frac{c^2 a}{132,000\, b}$$

4. In the absence of a series of experiments connecting p and v, c may be taken to represent the mean pressure for the stated cut-off and initial pressure, neglecting all wire-drawing effects, and b may then be found from the equation

$$b = \frac{c - p}{v},$$

p and v being the corresponding values of the mean pressure and piston speed found from an indicator-diagram taken at a piston speed of about 800 ft. per minute.

5. In this way a series of values of c and b may be easily found, and may be used to determine approximately the best piston speed for each particular cut-off.

6. The best piston speed for the maximum drawbar horse power is less than that for the maximum indicator horse power, and can be readily found when the efficiency of the engine itself is known.

7. The drop in pressure could possibly be reduced materially by designing short, straight ports of ample area and avoiding all crooked passageways for the steam.

Application of Results to Solution of Problems.—The foregoing results may be readily applied in the solution of many useful problems. For example, let it be required to find the speed on the level corresponding to the maximum drawbar horse power for a stated cut-off and boiler pressure.

The diameter of the driving wheel must be given, in order to express the train speed in terms of the mean piston speed, and also some estimate must be made of the engine resistance. The latter, reckoned up to the drawbar, may be expressed as a function of the load, or of the speed, or of both the load and the speed, but for the purpose in view it may be taken as constant and equal to 30 lbs. per ton at all speeds.

Let R denote the constant engine resistance in lbs. per ton,

- W the weight of the engine and tender,
- s the stroke in inches,
- D the diameter of the driving wheel in inches,
- v the piston speed in feet per minute,
- V the train speed in feet per minute,
- a the joint area of the two cylinders in sq. ins.

Then the rate at which work is done against engine resistance is

$$\text{WRV foot-lbs. per minute}$$

But $$V = \frac{\pi D v}{2s}$$

therefore the rate of working against the engine resistance is

$$\frac{\text{WRD}\pi v}{2s} = Qv,$$

where $$Q = \frac{\text{WR}\pi\text{D}}{2s}$$

and the rate of working in the cylinders is

$$pva \text{ where } p = c - bv.$$

Therefore the rate of working at the drawbar is given by

$$U = (c - bv)\,va - vQ \text{ foot pounds per minute.}$$

And this is a maximum when

$$\frac{dU}{dv} = 0$$

That is, when $$v = \frac{ac - Q}{2ab}$$

The problem may be extended to find the speed at which the drawbar horse power is a maximum, it being given, in addition to the data of the previous problem, that the train is to ascend a gradient of 1 in G.

The additional engine resistance against the gradient is $R_1 = \frac{2,240}{G}$ lbs. per ton, so that the total engine resistance against the gradient is $\frac{W\ 2,240}{G}$. The rate of working against this resistance is $\frac{2,240\ WV}{G}$ foot lbs. per minute; and expressing V in terms of the mean piston speed this becomes

$$\frac{2,240\ W\pi D v}{2sG} = Q_1 v$$

where $$Q_1 = \frac{2,240\ W\pi D}{2Gs}$$

The rate of working at the drawbar is now

$$pva - (Q + Q_1)\,v.$$

and from this, the speed for a maximum, found as in the previous example, is

$$v = \frac{ac - (Q + Q_1)}{2ab}$$

The more practical problem of calculating approximately the maximum load which an engine will take up a given gradient at a stated speed, cut-off and boiler pressure can be solved without difficulty if the engine and train resistances are known.

GRINDING HIGH-SPEED STEEL TOOLS.—High-speed steel tools can be ruined very easily in the machine shop by grinding them on the emery wheel until they get hot and then plunging them into water. After doing this, the cutting edge of the tools will be found full of cracks. One machine foreman complained that the tool dresser was cracking the tools in hardening, but a careful investigation showed that the tools had been cracked by grinding in this way. The man was instructed how to grind the high-speed tools properly and that put an end to the trouble from cracks in the tools.—*J. G. Jordan in I. R. M. B. Convention.*

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SHOP TESTS TO BE MADE OF AIR PUMPS AFTER GENERAL REPAIRS IN THE SHOPS

Test No	Name of M'n'f'r. of Pump	Size of Pump	Main Res'r Capacity Cu. In.	Steam Pressure in Lbs.	Position of Steam Throttle	Main Reservoir Pressure in Lbs.	Duration of Test Minutes	Size of Opening in Diaphragm through which Air is wasted	Thickness of Diaphragm not more than	Results Desired
1-A	Westinghouse	11 In.	22,200	160	Full Open	At beginning Atmospheric at close 150	[illegible]	No Waste		At end of 3 Minutes Reservoir Pressure to be not less than 150 Lbs.
2-A	Westinghouse	11 In.	22,200	160	Partly Open to give Speed of 52 Cycles per Min.	Maintained Constant at 75 Lbs.	60	13/64 In.	1/8 In.	Maintain Reservoir Pressure at 75 Lbs. for 60 minutes, at 52 Cycles of Pump per Min.
3-A	Westinghouse	11 In.	22,200	160	Full Open	Raise from 75 to 85	2	13/64 In.	1/8 In.	Raise Air Pressure from 75 to 85 Lbs. in 2 Min. against Leakage through Diaphragm
1-B	Westinghouse	9½ In.	22,200	160	Full Open	At beginning Atmospheric at close 150	5	No Waste		At end of 5 Minutes Reservoir Pressure to be not less than 150 Lbs.
2-B	Westinghouse	9½ In.	22,200	160	Partly Open to give Speed of 52 Cycles per Min.	Maintained Constant at 100 Lbs.	60	[illegible] In.	1/8 In.	Maintain Reservoir Pressure at 100 Lbs. for 60 minutes, at 52 Cycles of Pump per Min.
3-B	Westinghouse	9½ In.	22,200	160	Full Open	Raise from 100 to 120	[illegible]	[illegible] In.	1/8 In.	Follow Test 2-B and raise Air Pressure from 100 to 120 Lbs. in 5 Min. against Leakage through Diaphragm
1-C	Westinghouse	8 In.	22,200	160	Full Open	At beginning Atmospheric at close 150	5	No Waste		At end of 5 Minutes Reservoir Pressure to be not less than 150 Lbs.
2-C	Westinghouse	8 In.	22,200	160	Partly Open to give Speed of 65 Cycles per Min.	Maintained Constant at 100 Lbs.	60	[illegible] In.	1/8 In.	Maintain Reservoir Pressure at 100 Lbs. for 60 minutes, at 65 Cycles of Pump per Min.
3-C	Westinghouse	8 In.	22,200	160	Full Open	Raise from 100 to 130	2	[illegible] In.	1/8 In.	Raise Air Pressure from 100 to 130 Lbs. in 2 Min. against Leakage through Diaphragm
1-D	New York	No. 5	22,200	160	Full Open	At beginning Atmospheric at close 150	2	No Waste		At end of 2 Minutes Reservoir Pressure to be not less than 150 Lbs.
2-D	New York	No. 5	22,200	160	Partly Open to give Speed of [illegible] Cycles per Min.	Maintained Constant at 70 Lbs.	60	[illegible]/64 In.	1/8 In.	Maintain Reservoir Pressure at 70 Lbs. for 60 minutes, at 38 Cycles of Pump per Min.
3-D	New York	No. 5	22,200	160	Full Open	Raise from 70 to 80	19 Sec.	[illegible]/64 In.	1/8 In.	Raise Air Pressure from 70 to 80 Lbs. in 19 Sec. against Leakage through Diaphragm
1-E	New York	No. 2	22,200	160	Full Open	At beginning Atmospheric at close 140	2 Min. 10 Sec.	No Waste		At end of [illegible] Min. 10 Sec. Reservoir Pressure to be not less than 140 Lbs.
2-E	New York	No. 2	22,200	160	Partly Open to give Speed of 52 Cycles per Min.	Maintained Constant at 70 Lbs.	60	[illegible] In.	1/8 In.	Maintain Reservoir Pressure at 70 Lbs. for 60 minutes, at 52 Cycles of Pump per Min.
3-E	New York	No. 2	22,200	160	Full Open	Raise from 70 to 80	1	[illegible] In.	1/8 In.	Raise Air Pressure from 70 to 80 Lbs. in 1 Min. against Leakage through Diaphragm

TESTING AIR PUMPS AFTER GENERAL REPAIRS.

NEW YORK CENTRAL LINES.

It is just as important, and possibly more so, to test air pumps after they have been given general repairs as it is to test them after they are first built. Realizing this, the New York Central Lines have, after very careful study and investigation, drawn up a schedule of tests, as shown on the accompanying diagram. Not only are the pumps to be tested after they have received repairs, but it is expected that they will be regularly tested at intervals of six months while in service. The pressure of 160 pounds, required in order to test the pumps under conditions somewhat approximating those met in actual service, has made it necessary to install special boilers at several of the shops. We are indebted for information to Mr. F. M. Whyte, general mechanical engineer of the New York Central Lines.

STEEL VS. WOODEN TIES.—The life of wood white oak ties under heavy traffic ranges from four years on sharp curves to eight or ten years on tangents. There is a wide difference in the durability of timber, even when it is the same kind taken from the same pack of woods. It is beyond the ability of inspector or trackman to select ties that will give the same duration of service. The tie begins to deteriorate from the time it is put in place, the rate of deterioration increasing until it becomes necessary to remove the tie. There is no track work that compensates fully for this deterioration, so you cannot maintain a condition equal to an all new tie track. The steel tie maintains its section, and the bed under the tie does not have to be disturbed on account of tie becoming soft, nor on account of the effective thickness of the tie becoming less, due to rail or tie plate bedding into the tie. The steel tie, up to failure, retains the same dimensions and efficiency, reducing the work required for surfacing and lining, and it is possible throughout the life of the tie to maintain track of the same excellence as with all new ties. Up to the present time we have only had one broken rail on steel ties, and the report attributes this break to a flaw in the rail. We have not used steel ties long enough to determine their life under our conditions, but an examination of a broken tie, after six years' service, does not indicate that rusting under ordinary conditions should cause any anxiety. I somewhere read a statement that Mr. Post, chief engineer of the Netherland State Railroad, found that ties weighing 125 lbs., laid in sand and gravel ballast, had decreased 8¾ lbs. in 35 years, but were still good for 20 years' service.—*Mr. H. T. Porter, before Railway Club of Pittsburgh.*

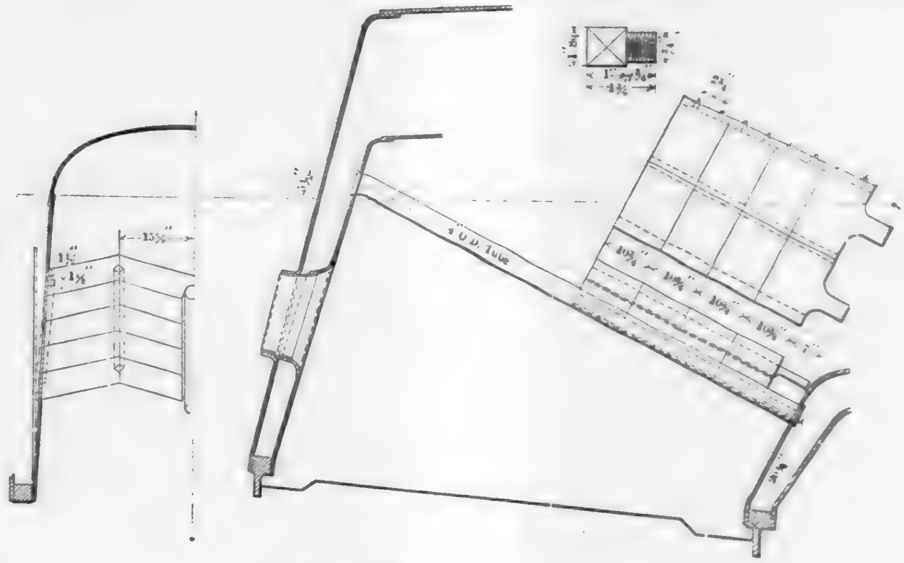
RAILROAD Y. M. C. A.—Sixteen new railroad association buildings have been opened and ten other new associations have been organized, two of them among street railway men, making a total of 225. The membership is over 81,000 and there are now 149 buildings owned and occupied having a total valuation of $2,601,350. In addition, sixteen other buildings are now being constructed at a cost of $538,000, and these when completed will make 165 buildings with a total valuation of $3,139,350. The international railroad secretaries are now eleven in number, eight devoting their entire time and three part time to this department. Two of these, J. M. Dudley, with headquarters at Montreal, and Richard C. Morse, Jr., for educational work on the Gould lines, have been added during the past year. Mr. Moore has been assigned to the New York Central lines. F. B. Shipp, who has, for several years past, been in charge of the work in the southwest, with headquarters at St. Louis, has been transferred to the New York office with a relation to the general work; E. L. Hamilton has been assigned to the territory previously looked after by Mr. Shipp. The contract has been let and ground broken for the new Gould Memorial Building for railroad men at St. Louis, Mo. This building will exceed in cost $200,000.

TECHNICAL MEN IN THE MOTIVE POWER DEPARTMENT.—While a collegiate technical education is undoubtedly an advantage to those who will diligently apply themselves and fully embrace the opportunity offered by the information and knowledge gained in the use of books and instruments, it is not a necessity, and many college-bred men fail, because of their indisposition to go through the probationary period of practical mechanics and thereby learn how to secure the respect of, and to supervise men, and convey information in a manner that will produce results, where the more practical and industrious man will succeed.—*J. E. Muhlfeld, in The Railroad Gazette.*

FIRE BRICK ARCH.

NORTHERN PACIFIC RAILWAY.

A brick arch for wide firebox locomotives, which is supported by a single arch tube, is in use on a large number of locomotives on the Northern Pacific Railway and was applied to the large order recently built by the American Locomotive Company, which were illustrated in our October issue, page 392. The arch was designed by Mr. David Van Alstyne, former superintendent of motive power, and the illustration shows the one as applied to a Pacific type locomotive with a combustion chamber. It will be seen that the bricks arch on either side of the center, being supported by a 4-in. tube in the middle of the box and by square-headed studs, of which there are two to each brick, on the side sheets. A space of 7 ins. is left between the arch and the firebox throat sheet, and the complete arch consists of four rows of brick, each $10\frac{3}{4}$ ins. wide, making it extend 50 ins. diagonally upward from the sheet.



IRE BRICK ARCH, NORTHERN PACIFIC RAILWAY.

THE BEST METHOD OF SETTING FLUES.

BY G. G. NICOL.*

I have tried many different ways of setting flues in locomotive boilers, and the best method I have found, covering all classes of engines, is as follows:

Carefully inspect back flue sheet and see that all scale and sediment is removed from the inside of both flue sheet and flue holes and that all flue holes are perfectly round. Care should be taken to have the sharp corners removed from inside and outside of flue holes, leaving a good fillet, so that no damage can be done to the flue from sharp corners. Then insert copper ferrules in flue holes and expand with a sectional expander, leaving it flush with fire side of flue sheet. Copper ferrules should be a neat fit. I do not believe in stretching coppers, but if this is necessary they should be reannealed, as hammering copper hardens it and reduces its expansion. It should be left as soft as possible. Swedge the flues to a neat fit and remove all scale from the end of the flues, then apply them, leaving 3/16 in. outside of the sheet for bead, or $1\frac{1}{2}$ the thickness of the flue. This would give you, with a No. 11 gauge flue, 3/16 of an inch, which I think is plenty for any bead. After flues have all been clinched, mandrel them out to copper, so as to admit sectional expander, then drive expander once into each flue, fastening them to the proper length for head. After flues have been fastened in this manner, turn them over with a ball-face hammer, or a suitable tool to fit the pneumatic hammer. Then roll all the flues, commencing at the two top corners, next roll the center flues and then the bottom ones. Then prosser them in the same order as in rolling, turning the sectional expander twice in each flue. By so doing, I think, the expansion is distributed all over the sheet. Finish flues by beading with the standard tool.

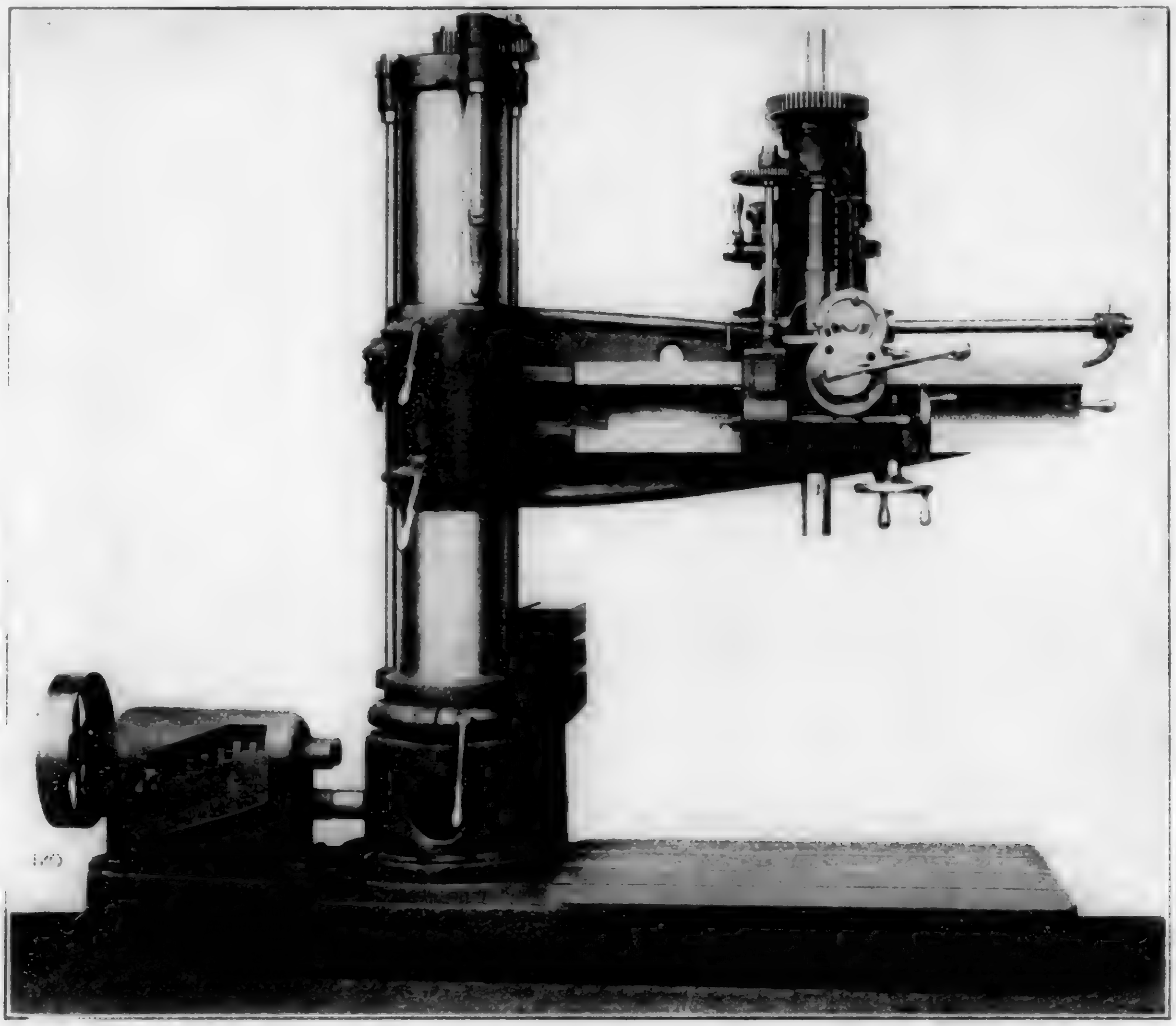
The reason for rolling the flues before the sectional expander is used is because when they are rolled tightly back against the flue sheet the expander only has to do its proper share of the work, putting the shoulder on the flue inside the flue sheet. Rolling the flues after they are expanded shoves the shoulder away from the sheet and takes out most of the shoulder that the expander has made.

I find that heavy copper ferrules give better results than light ones, and would recommend them to be not lighter than 40 lbs., because the heavier the copper, the greater the expansion. I also recommend a long ferrule, which should project through the flue sheet at least ½ in., for the reason that heavy scale or sediment will not adhere to copper, and the further we can keep mud and scale from the flue sheet the longer we can keep flues from leaking. As soon as the water spaces next to the back flue sheet become clogged with scale your cooling capacity is cut out and the flues begin to leak.

*Foreman-boilermaker, C., R. I. & P. R. R. From a paper before the Master Steam Boiler Makers' Association.

ELECTRICAL CUTTING OF STEEL BEAMS AND GIRDERS.—The fire at San Francisco, Cal., following the earthquake of April 18, left some difficult problems to be solved in the clearing away of debris for new buildings. One of the most serious of these is the removing of the tangled mass of structural steel. It occurred to R. E. Frickey that the electric arc might be employed here to advantage, and he carried out at the University of California some experiments to determine the possibilities of this use of the arc. As the result of extensive experiments, described by the San Francisco *Journal of Electricity, Power and Gas*, an electrode has been evolved which has proved successful. By means of this electrode a 15-in. beam was cut in two in 20 minutes. To make a corresponding cut with a hack saw would require several hours. For the best and most economical results a current of about 250 amperes at from 90 to 100 volts is required. In starting, a resistance is employed, but this may be cut out after the arc is formed. One necessary condition for success is the satisfactory protection of the operator. Not only the eyes, but the face and hands must be covered or they will be badly burned. An oilcloth hood having a rectangular opening in front of the eyes is employed, this opening being covered by a mask of oilcloth having a window of specially prepared glass when the arc is in operation. Gloves must be worn. Since it is not practical to obtain 110 volts for the work in San Francisco, and it was not advisable to use the 220-volt system, since the neutral is grounded in that city, a portable generating set consisting of a gasoline engine driving a dynamo was arranged.—*Iron Age*.

A NEW NOISELESS GEAR.—The *Iron Age* recently presented a description of a noiseless gear invented by Frank E. Bocorselski, superintendent of the Baush Machine Tool Company, Springfield, Mass. It consists of a cast iron blank, with a sleeve, upon which are fitted three rings, each of a different material: bronze, fiber and steel. These sections are held in place by a key and by three riveted pins, thus forming of the four materials a practically solid gear blank. An exhaustive test of one of these gears has been made in a 42-in. Baush boring mill in mesh with a cast iron gear. The desired noiseless quality commonly accomplished by rawhide and similar gears was demonstrated, and also the wearing quality, which was the inventor's chief purpose.



BICKFORD NEW PLAIN RADIAL DRILL.

HUDSON RIVER TUNNEL OF THE PENNSYLVANIA RAILROAD.—This tunnel, which comprises two single track tubes between Weehawken, N. J., and New York City, reached the end of the first stage toward completion on Tuesday, September 11, at which time the headings met in the north tube. The headings had been advanced continuously from both shores, by shield working, and the point of meeting was near the middle line of the river. An opening through the two shields was made in the afternoon of September 11, and on the following day a celebration party went through. The tunnel is being built by the O'Rourke Engineering Construction Company, the contract being made on May 2, 1904. As the distance between shafts is about 6,500 ft., the average rate of advance has been 8 ft. per day, or 4 ft. per day heading. The two tubes are parallel and on the same level throughout. Its grades are 1.92 per cent. on the New York side and 1.30 per cent. on the New Jersey side. Each tube is circular, 23 ft. in diameter over the shell. The shell is a cast iron (in some places cast steel) sectional tube, which later is to be lined with 2 ft. of concrete. Special segments in the bottom, every 15 ft., make provision for later sinking metal screw piles through the bottom of the tunnel to rock, in order to prevent all possibility of disturbance of the structure from the effects of operating heavy trains at high speed through the tunnel.

THE LARGEST CASTING.—The largest casting ever made in the United States has recently been completed by the Bethlehem Steel Company; it is the frame for a 17½-ft. gap. hydraulic riveter for the Lehigh Valley Railroad shops at Sayre, Pa. It is designed for a maximum pressure of 150 tons per sq. in. A special car was required to transport the machine.—*American Machinist.*

PLAIN RADIAL DRILL.

The plain radial drill shown in the illustration is made in three sizes, 4, 5 and 6 ft. An exceptionally large number of spindle speeds are provided (twenty-four), extending over a wide range, the maximum speed in each case being 13.63 times the minimum. The minimum speed of the 6-ft. drill is adapted to drive a 6-in. pipe tap; that of the 5-ft., a 5-in.; that of the 4-ft., a 4-in. The spindle speeds of the 4-ft. drill range from 22.5 to 306.7 r.p.m., as shown on the following table:

No. of rev. per min. made by spindle.	Diam. of drills for which speeds are suitable.	Actual number of feet per min. at which drilling is done.	Theoretical number of feet per min. at which drilling hould be done.
306.7	7/16	35.13	35.35
268.8	½	35.18	35.00
238.5	9/16	35.10	34.65
214.7	⅝	35.13	34.30
195.2	11/16	35.30	33.95
174.1	¾	34.20	33.60
156.1	13/16	33.20	33.25
143.4	⅞	32.85	32.90
121.2	1	31.73	32.20
106.2	1⅛	31.28	31.50
94.2	1¼	30.83	30.80
84.8	1⅜	30.53	30.10
77.1	1½	30.28	29.40
68.8	1⅝	29.27	28.70
62.1	1¾	28.45	28.00
56.6	1⅞	27.78	27.30
48.2	2	25.24	26.60
42.2	2⅛	23.48	25.90
37.5	2¼	22.09	25.20
33.6	2½	21.99	23.80
30.7	2¾	22.10	22.40
27.4	3	21.52	21.00
24.7	3¼	21.03	21.00
22.5	3½	20.63	21.00

It will be seen that suitable speeds are provided for drilling diameters advancing by sixteenths from 7-16 to ⅞ in.; by eights from ⅞ to 2¼ ins., and by quarters from 2¼ to 3½

ins. With the large number of spindle speeds and the small steps it is possible to very nearly approximate the proper speed for any material or size of drill which it is desired to use, and to run the drill as closely as practicable to its limit of endurance.

The different spindle speeds are obtained by two levers, one of which is located on the head and controls the three back gear speeds, and the other projects from the speed box and controls eight speeds. The speed box is similar to the one which was described on page 460 of our December, 1905, issue. The eight speeds are obtained from 12 gears, only three of which are in service at any one time. The mechanism is of the tumbler variety, but the maximum difference in the peripheral speed of the gears is within the limit of 2 to 1, so that the shock which occurs when changing from one speed to another is comparatively slight and has no serious effects.

There are eight feeds ranging in geometrical progression from .007 to .064 per revolution of the spindle; any one of these is instantly available. The tapping mechanism is located on the head, and is controlled by a lever conveniently placed for the operator. The taps may be backed out at any speed with which the machine is provided, regardless of the speed with which they are driven in. A depth gauge is provided, which answers the double purpose of enabling the operator to read all depths from zero, thus doing away with the delay due to scaling or calipering, and it also supplies a convenient means for setting the automatic trip, the graduations showing exactly where the dog should be placed in order to disengage the feed at the desired points. The automatic trip operates at as many different points as there are depths to be drilled at one setting of the work, and in addition it leaves the spindle free, after any intermediate tripping, to be advanced or raised and advanced or traversed its entire length without disturbing the set of the dogs. It also throws out the feed when the spindle reaches the limit of its movement. These machines are made by the Bickford Drill & Tool Company, Cincinnati, Ohio.

EVERETT-McADAM CONTINUOUS ELECTRIC BLUE PRINTING MACHINE.

In practically all modern drafting rooms the old method of blue printing by sunlight has been very largely abandoned in favor of a machine printing by means of electric light. The many advantages of the later method in the matter of convenience, rapidity and expense are so evident that it is not necessary to repeat them.

From its first stage, where the electric light was simply substituted for sun light, the ordinary printing frames and other apparatus being used, this system of blue printing has passed through several stages of development, each new machine having some important points of advantage over its predecessor, until at present it would seem impossible to improve the efficiency or rapidity of making blue prints over than that obtained with the latest machines.

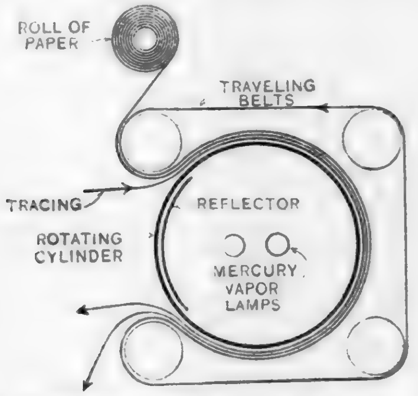
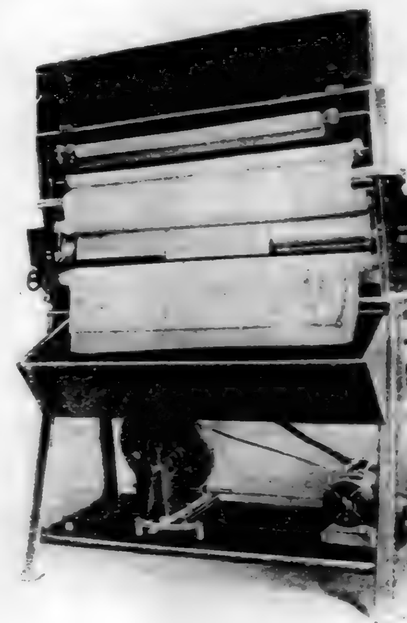


DIAGRAM SHOWING METHOD OF PRINTING.

One of the latest and most modern of these blue printing machines, which has only been on the market for about one year, is that manufactured by the Revolute Machine Company of 523 W. 45th Street, New York, to which the illustrations herewith refer.

This machine consists briefly of a rotating glass cylinder which lies in a series of narrow belts and within which are placed two mercury vapor electric lamps. The roll of paper to be printed is placed in the box at the top of the machine and feeds in continuously between the belts and the cylinder, or if only a few prints of small size are wanted, previously cut sheets of paper may be fed in. The tracings are inserted between the paper and the glass cylinder, and after passing around three-quarters of the circumference of the cylinder they are printed and deposited in the box with the paper located in the front of the machine below the cylinder. The cylinder is driven through gearing by an electric motor and its speed of rotation, and hence the length of time given to the printing can be varied at will.



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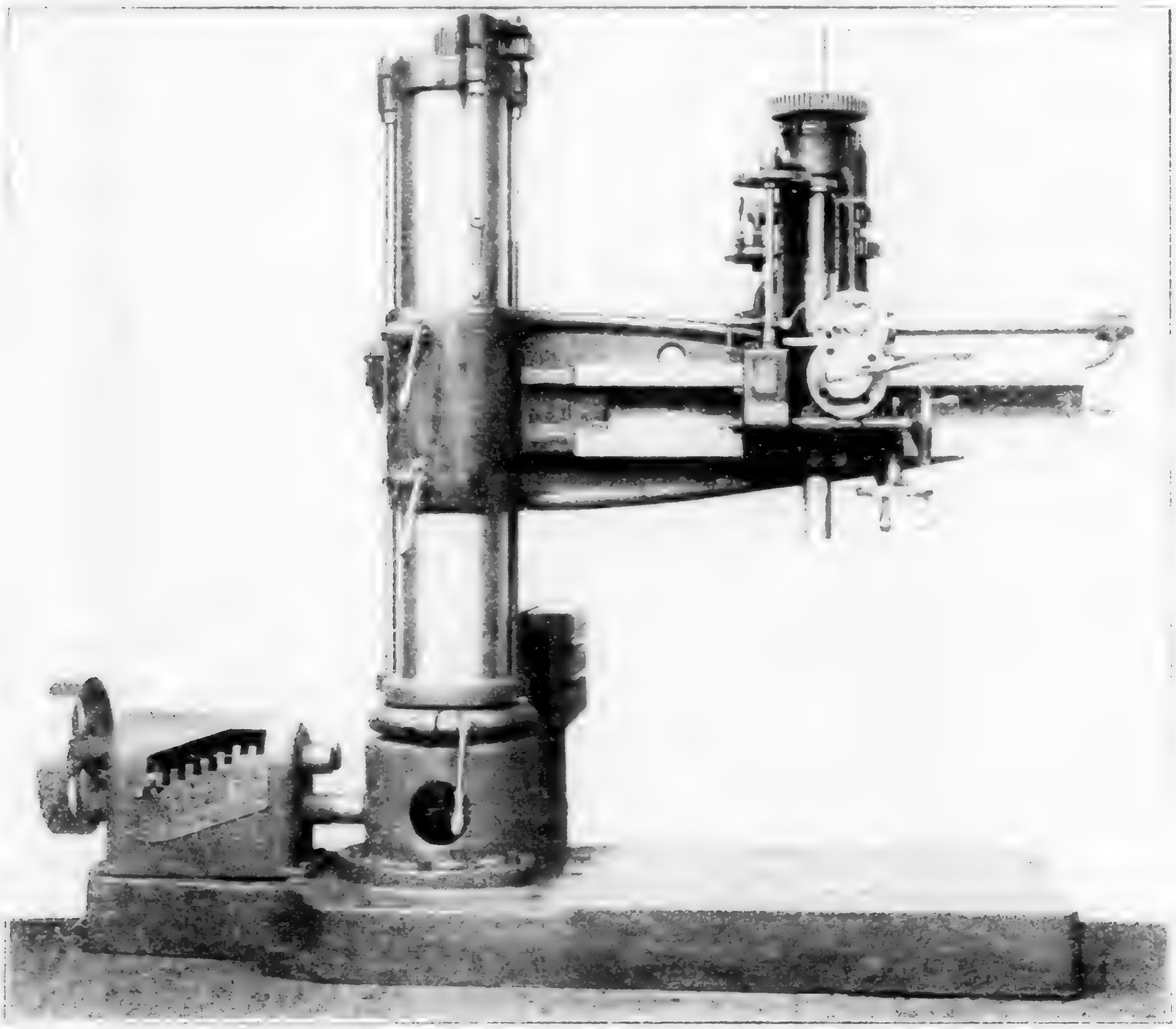
A unique feature of the machine is the use of a number of 1½-in. belts instead of a single broad one. In this way absolutely perfect contact is obtained, which was found to be impossible by the use of a single broad belt. The mercury vapor electric lamps are particularly well adapted for this kind of work, as they give out only chemical rays. The lamps are so situated that the light strikes the paper at right angles at all times, and the machine has a maximum electrical efficiency.

The whole machine is very compact, requiring a space of only 2 x 5 ft., and is entirely self-contained. It is possible to make prints 5 ft. wide and of any length whatever, and the machine is particularly well adapted for making large numbers of small prints on one long sheet of paper, or previously cut sheets which come out in a regular stream and are all of uniform tone. The tracings go in and come out on the same side of the machine, so that the leading edge of the tracing may be fed into the machine again before the trailing edge comes out. This saves time when more than one print is wanted from one tracing, and was very nicely illustrated recently by making 12 prints from one 6-ft. tracing on a single sheet of paper 72 ft. long, without wasting a single inch of paper or a second of time between the prints.

Although this company has been formed but one year there are at present 40 of these machines in daily use which are said to be giving absolutely perfect satisfaction.



BICKFORD NEW PLAIN RADIAL DRILL

[illegible] Tunnel of the Pennsylvania Railroad.—This tunnel, which comprises two single track tubes between Weehawken, N. J., and New York City, reached the end of the first stage toward completion on Tuesday, September 11, at which time the headings met in the north tube. The headings had been advanced continuously from both shores, by shield working, and the point of meeting was near the middle line of the river. An opening through the two shields was made in the afternoon of September 11, and on the following day a celebration party went through. The tunnel is being built by the O'Rourke Engineering Construction Company, the contract being made on May 2, 1904. As the distance between shafts is about 6,500 ft., the average rate of advance has been 8 ft. per day, or 4 ft. per day heading. The two tubes are parallel and on the same level throughout. Its grades are 1.92 per cent. on the New York side and 1.30 per cent. on the New Jersey side. Each tube is circular, 23 ft. in diameter over the shell. The shell is a cast iron (in some places cast steel) sectional tube, which later is to be lined with 2 ft. of concrete. Special segments in the bottom, every 15 ft., make provision for later sinking metal screw piles through the bottom of the tunnel to rock, in order to prevent all possibility of disturbance of the structure from the effects of operating heavy trains at high speed through the tunnel.

The Largest Casting.—The largest casting ever made in the United States has recently been completed by the Bethlehem Steel Company; it is the frame for a 17½-ft. gap, hydraulic riveter for the Lehigh Valley Railroad shops at Sayre, Pa. It is designed for a maximum pressure of 150 tons per sq. in. A special car was required to transport the machine.—*American Machinist*

PLAIN RADIAL DRILL.

The plain radial drill shown in the illustration is made in three sizes, 4, 5 and 6 ft. An exceptionally large number of spindle speeds are provided (twenty-four), extending over a wide range, the maximum speed in each case being 13.63 times the minimum. The minimum speed of the 6-ft. drill is adapted to drive a 6-in. pipe tap; that of the 5-ft., a 5-in.; that of the 4-ft., a 4-in. The spindle speeds of the 4-ft. drill range from 22.5 to 306.7 r.p.m., as shown on the following table:

No. of rev. per min. made by spindle.	Diam. of drill for which speeds are suitable.	Actual number of feet per min. at which drilling is done.	Theoretical number of feet per min. at which drilling should be done.
306.7	7/16	35.13	35.35
268.8	½	35.18	35.00
238.5	9/16	35.16	34.65
214.7	⅝	35.13	34.30
195.2	11/16	35.36	33.95
174.1	¾	34.20	33.60
156.1	13/16	33.26	33.25
143.4	⅞	32.85	32.90
121.2	1	31.73	32.20
106.2	1⅛	31.25	31.50
94.2	1¼	30.88	30.80
84.8	1⅜	30.53	30.10
77.1	1½	30.28	29.40
68.8	1⅝	29.27	28.70
62.1	1¾	28.45	28.00
56.6	1⅞	27.78	27.30
48.2	2	25.24	26.60
42.2	2⅛	23.48	25.90
37.5	2¼	22.09	25.20
33.6	2½	21.99	23.80
30.7	2¾	22.10	22.40
27.4	3	21.52	21.00
24.7	3¼	21.03	21.00
22.5	3½	20.63	21.00

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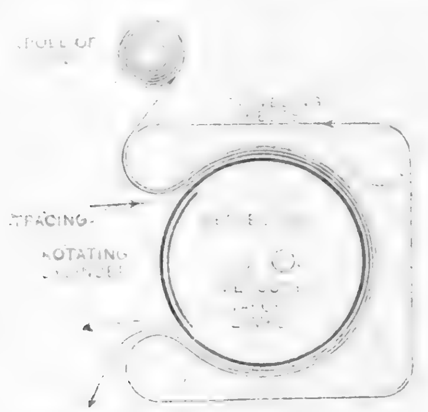

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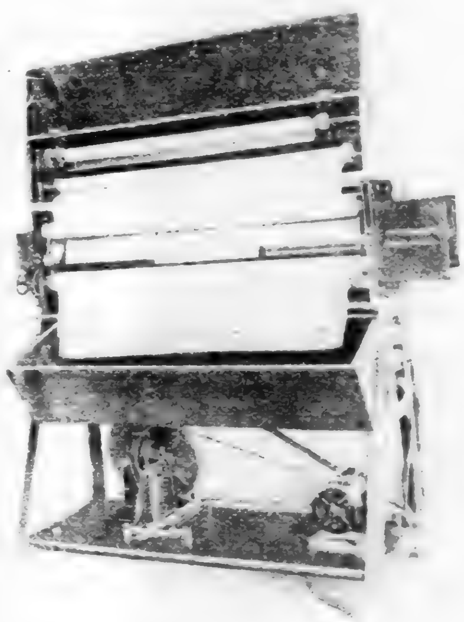

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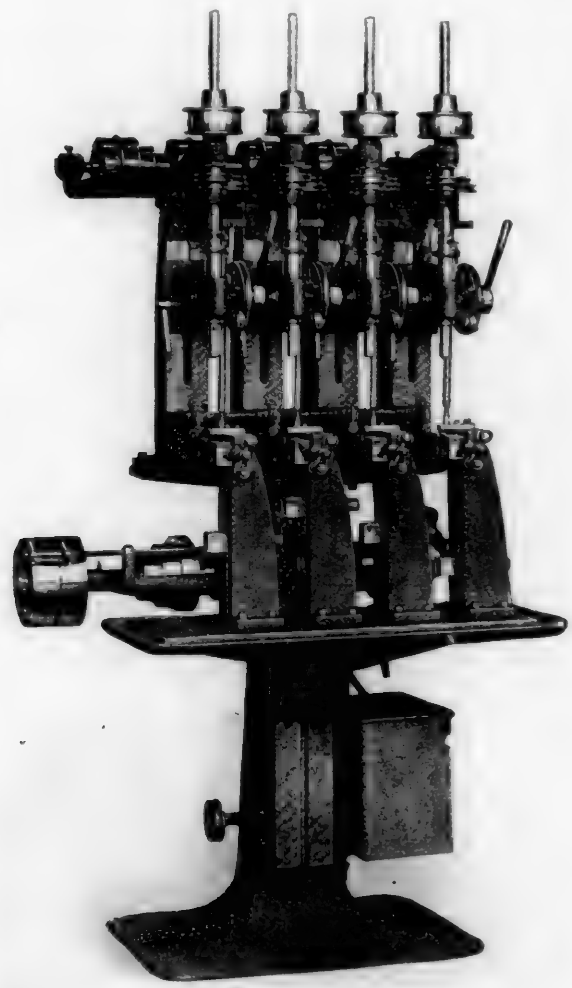
FOUR-SPINDLE STAY BOLT DRILL.

The four-spindle drill, shown in the illustration, has been especially designed for drilling tell-tale holes in staybolts. It will drill to 3 ins. in depth, using drills up to 5-16 in., and will take staybolts from ¾ to 1¼ ins. in diameter and from 3 to 15 ins. long. The construction of the special chucks, which quickly grip and center the staybolts under each spindle, is shown on the drawing. The lower end of the staybolt



FOUR-SPINDLE STAY-BOLT DRILL.

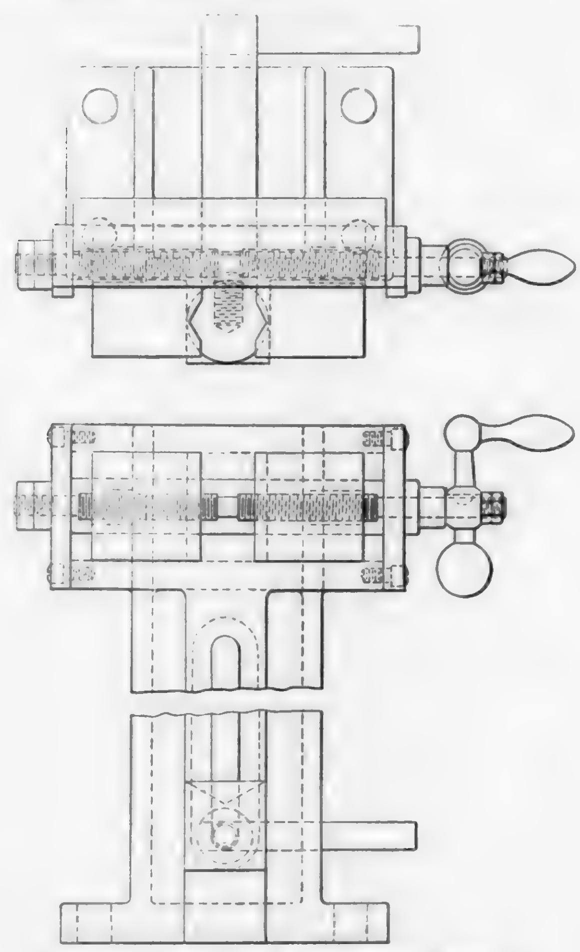
rests in the bell center of the block, which may readily be adjusted to the proper height. The upper end of the bolt is securely gripped by the two jaws. The chucks are set central with each spindle, and a bushing is provided for the drill to run in, insuring its starting central with the piece in the chuck.

Each spindle has three independent speeds and two independent feeds; also an automatic knock-off. Either the feed or speed may be instantly changed for any one spindle without regard to the others. If desired, the staybolt fixtures may easily be removed, and the machine may be used for a variety of sensitive drill work. The spindles are 6½ ins. apart; the distance from the center of the spindle to the face of the upright is 7½ ins.; the maximum distance from the nose of the spindle to the top of the table is 36 ins., while the minimum is 4 ins. The length of the power feed is 3 ins., and the spindle also has a hand feed and quick return. The table is counterbalanced by a weight inside the column.

An oil pump, tank and piping are provided so that oil or soda water may be used in liberal quantities. The machine is made by Foote, Burt & Company of Cleveland, and weighs about 1,200 lbs.

A Mistake Made by Our Technical Schools.—The technical schools have filled a want and have done much good in certain branches of industry, but they assume too much when they undertake to give a young man a course in conservation of forces, statics and dynamics, graphic statics, strength of materials, mechanics, drawing, machine design, mechanical engineering and shop practice, all in the short space of four years. He is given a diploma, signifying he has nothing more to learn and is capable of taking the management of a factory. I had a young man as draftsman who had taken an engineering course in one of the Boston technical schools. He carried a sample of work with him which he had made during his course in shop practice. It consisted of two pieces of cast iron about 2 in. sq. and 1 in. thick. One piece had a groove about ⅜ in. sq. cut across the face, the other piece had a corresponding projection across its face, together forming a tongue and groove. These pieces were accurately fitted together, so that the tongue could slide from end to end, and when reversed fit just as accurately. I asked the young man what tools he had to do the job with. He replied: hammer, chisel, file and scraper. I then asked him how long it had taken him to make the piece. He said that he had spoiled two or three pieces before he got them to fit, and that in all he had probably spent three or four days upon the job. Any modern machine shop could duplicate those pieces with profit for 15 cents or 20 cents apiece. *Time and cost* are the main functions in productive science, and when these essential features are not included in the so-called shop practice the true object of technology is lost.—*Mr. Thomas Hill, before the Western Society Associated Engineers.*

Large Freight Car Orders.—The New York Central Lines have recently placed orders for a total of 17,050 freight cars, and the Pennsylvania Railroad Company has ordered a total of 12,415 freight cars. This makes 29,465 cars to be built for two railroad companies during the next year, most of which will be delivered before August, 1907.



STAY-BOLT CHUCK, FOUR-SPINDLE DRILL.

ADJUSTABLE BUSHINGS FOR DIE STOCKS.

The Bard adjustable bushing for Armstrong die stocks is a time and trouble saving improvement over the ordinary ring bushing. It is made in four sizes, each size taking the same range of pipe as the corresponding number of the stock. One of these bushings is shown attached to the stock in the accompanying illustration. It consists of a strong malleable iron body, having a sleeve fitting into the barrel of the stock. A simple twist of the cam plate brings a set of hardened jaws firmly against the pipe, centering it at the same time. The cam plate is then secured by a thumb-screw, insuring an abso-

ADJUSTABLE BUSHING FOR DIE STOCKS.

lutely accurate and straight thread. When a crooked thread is desired, however, it may be cut as easily as with the old style ring bushings.

This adjustable bushing saves the time of looking up lost and misplaced ring bushings and fitting them to the stock. It is also, of course, much more satisfactory and accurate than the makeshift of wrapping paper or tin around the pipe when the exact size of bushing cannot be found. There is no necessity of carrying a set of bushings in the kit when one of these adjustable bushings has been fitted to the stock. The design is very simple and strong, and when once fitted to the stock there need be no occasion for removing it. These bushings are made by The Armstrong Manufacturing Company, Bridgeport, Conn.

The Future Prime Mover.—It is less than one hundred and fifty years since Watt made the reciprocating steam engine a thing of actual use and fairly began the era of manufactured power. Already the reciprocating steam engine is doomed, except for certain special uses. The development of the transmission of power by electricity has made it possible to use the high efficiency of the steam turbine, and the use of turbo-generators is even now large and spreading fast. But the turbine is only a step. Its successor is already foreshadowed in the gas engine. Side by side with these changes in the type of prime mover advances the art of transmitting and using power by electricity, and so swiftly does the art advance that now the day seems close at hand when we may see short, but important, lines of steam railroad of heavy traffic converted to electric working. The power houses will be equipped with steam turbines or with gas engines. Alternating current will be sent out over long transmission lines and stepped down and used in the car motors without converting. Two great things will be accomplished. Working cost will be reduced and the public will have more frequent, cheaper, and perhaps swifter, service.—*Col. H. G. Prout.*

PERSONALS.

Mr. J. F. Ashworth has been appointed master mechanic of the Tennessee Railroad.

Mr. J. A. McRae has been appointed mechanical engineer of the Michigan Central R. R.

Mr. Chas. Zeity has been appointed general foreman of the Colorado City shops of the Colorado Midland Ry.

Mr. W. J. Haynen, master mechanic of the Detroit, Toledo & Ironton Ry. at Springfield, O., has resigned.

Mr. F. C. Keim has been appointed master mechanic of the Sierra Ry., with headquarters at Jamestown, Cal.

Mr. S. C. Smith has been appointed general foreman of the Cleveland, Cincinnati & St. Louis Ry. at Delaware, O.

Mr. John W. Harris has been appointed road foreman of engines of the Philadelphia & Reading Ry. at Tamaqua.

Mr. J. W. Sanford, master mechanic of the Pennsylvania R. R. at Meadows, N. J., has been retired on a pension.

Mr. L. L. Young, traveling engineer, has been appointed acting master mechanic of the Detroit, Toledo & Ironton Ry. at Springfield, O.

Mr. W. L. Calvert has been appointed master mechanic of the Missouri Pacific Ry. at McGehee, Ark., succeeding Mr. R. G. Long, resigned.

Mr. M. S. Curley has resigned as superintendent of motive power on the Sierra Railway of California, and that position has been abolished.

Mr. Frank Malone has been appointed general foreman of the Oregon Short Line at Pocatello, Idaho, in place of Mr. L. A. Richardson, resigned.

Mr. C. M. Stuart has been appointed to succeed Mr. Allen as master mechanic of the Shamokin division, of the Philadelphia & Reading Ry.

Mr. W. E. Farrell has been appointed general foreman of roundhouse and shops of the Cleveland, Cincinnati & St. Louis Ry. at Columbus, O.

Mr. G. E. Parks, mechanical engineer of the Michigan Central R. R., has been promoted to the position of master mechanic at Jackson, Mich.

Mr. L. Pfafflin has been appointed master mechanic of the Indianapolis Union Ry., with office at Indianapolis, Ind., to succeed O. H. Jackson, deceased.

Mr. R. MacKenzie has been appointed divisional car foreman of the Atlantic division of the Canadian Pacific Railway, with headquarters at McAdam.

The office of Mr. T. Paxton, superintendent of motive power of the El Paso & Southwestern Ry., has been moved from Douglas, Ariz., to El Paso, Tex.

Mr. R. Griffith has been appointed master mechanic of the Colorado Midland Ry., with office at Colorado City, Colo., succeeding Mr. W. J. Schlacks, resigned.

Mr. Michael Hassett has been appointed general engine dispatcher of the Western division of the New York Central & Hudson River R. R., at Buffalo, N. Y.

Mr. F. J. Lass has been appointed acting mechanical engineer of the Mexican Central Ry., with office at Aguascalientes, Mex., vice Charles T. Bayless, deceased.

Mr. M. J. Schneider has been appointed superintendent of motive power of the National R. R. of Mexico, with office at Laredo, Tex., succeeding James Farrell.

Mr. F. L. Macfarlane, storekeeper of the Chicago, Burlington & Quincy Ry. at Denver, Colo., has been transferred to Sheridan, Wyo., vice Mr. F. J. Angler, promoted.

Mr. J. H. Tinker has been appointed master mechanic of the Chicago & Eastern Illinois R. R., with headquarters at Danville, Ill., succeeding Mr. W. J. Hoskin.

Mr. C. R. Naylor, assistant chief clerk, motive power department, Atchison, Topeka & Santa Fe Ry., has resigned, and accepted a position with the Symington Co.

Mr. J. H. Drennan of the Atchison, Topeka & Santa Fe Ry. car department at Wichita, Kansas, has been made joint foreman of the Santa Fe-Frisco car department.

Mr. J. W. Cain, assistant engineer of tests of the Gulf, Colorado & Santa Fe Ry. at Cleburne, Tex., has resigned to accept a position with McCord & Company of Chicago.

Mr. George H. Lickert has been appointed master mechanic of the Colorado division of the Union Pacific R. R. at Pullman, Colo., in place of Mr. George Thompson, resigned.

Mr. W. H. Hudson, general master mechanic of the Southern Ry. at Birmingham, Ala., has been appointed district general master mechanic, with headquarters at Knoxville, Tenn.

Mr. George Thompson has been appointed superintendent of motive power of the Denver, Northwestern & Pacific Ry., with headquarters at Denver, Colo., vice Mr. A Struthers, resigned.

Mr. H. E. Malone, general foreman of roundhouse and shops of the Cleveland, Cincinnati, Chicago & St. Louis Ry. at Columbus, O., has been appointed general foreman of shops at Springfield, O.

Mr. W. C. Whittaker has resigned as general foreman of Colorado City shops of the Colorado Midland Ry., and has been appointed general superintendent of the Hussell Iron Works at Colorado Springs.

Mr. R. L. Kleine has been appointed chief car inspector of the Pennsylvania R. R., and will be attached to the office of the general superintendent of motive power at Altoona, Pa., vice Mr. J. F. Elder, retired.

Mr. L. A. Richardson, general foreman of the Oregon Short Line at Pocatello, Idaho, has been appointed division master mechanic of the Chicago, Rock Island & Pacific Ry. at Trenton, Mo., in place of Mr. A. C. Adams.

Mr. C. F. Roberts, general foreman at Monterey, Mex., has been appointed master mechanic of the San Luis division of the Mexican Central Ry., with office at Cardenas, Mex., succeeding Mr. J. J. Cavanaugh, resigned.

Mr. J. B. Dorsey, formerly master mechanic of the Denver & Rio Grande R. R., at Leadville, Colo., has been appointed master mechanic of the Cincinnati, Hamilton & Dayton Ry., with headquarters at Indianapolis, Ind.

Mr. Earl C. Metzger, recently assistant superintendent of Nelson Morris & Co.'s Car Works, Chicago, has resigned, and has accepted the position of mechanical engineer with the Hicks Locomotive & Car Works, Chicago.

Mr. George S. Allen, master mechanic of the Shamokin division of the Philadelphia & Reading Ry. at Tamaqua, Pa., has retired after a continuous service of 52 years with that road. He has been master mechanic at Tamaqua since March 1, 1871.

Mr. J. A. Baker, formerly master mechanic of the Southern Pacific Ry. at Houston, Tex., has been appointed master mechanic of the Beaumont, Sour Lake & Western Ry., the Colorado, Southern, New Orleans & Pacific Ry. and the Orange & Northwestern Ry., with headquarters at Beaumont, Tex.

Mr. Walter Reid has been appointed acting road foreman of engines of the Los Angeles division of the Atchison, Topeka & Santa Fe Ry. at San Bernardino, Cal., temporarily relieving Mr. J. B. Galivan of that part of his duties which pertain to the position of road foreman of engines.

BOOKS.

Catechism of the Electric Headlight. 94 pages. Vest pocket size. Published by the *Brotherhood of Locomotive Firemen's Magazine*, Indianapolis, Ind. Price, 50 cents.

This little book is a compilation of questions and answers concerning the locomotive electric headlight. These were published in the *Locomotive Firemen's Magazine* during the year 1905, and include 296 questions and answers, which covers the subject even to its most minutest details as far as the operation and repair is concerned. This volume is well adapted in use for examination of firemen for promotion as well as a study for progressive firemen or engineers. It is accompanied by a number of illustrations on a separate sheet.

Cost of Locomotive Operation. By G. R. Henderson. 192 pages. Standard 6 x 9 ins. Cloth. Published by the *Railroad Gazette*, 83 Fulton Street, New York. Price, $2.50.

The cost of operating locomotives represents about one-third of the total working expenses of railroads, or one-fifth of the total revenue, and it is quite true, as is stated in the first chapter of this book, that, "on large systems the total is a vast amount, running into many millions yearly, yet, in spite of this fact, there is little *definite* information regarding the various individual items of expense, when by 'definite' we mean the actual expenditure per unit of work accomplished. It is true that we can divide the total figures of any one account by the engine mileage, train mileage, ton mileage, or any other factor, and obtain a unit cost for the system or division, but this will not differentiate the uphill and level work, or the slow and time freights, nor can we gather any idea of the cost per horse-power developed per hour, nor the effect of grades, speed, loading, etc. We can further make comparisons between the monthly performances of locomotives, in order to determine whether the coal consumption per engine or ton mile is increasing or diminishing, but if it be increasing, it is often difficult to assign a reason for it, although a perfectly logical one may exist. It is on account of these that this work is undertaken, with the hope of clearing up in part, at least, the uncertainties arising from variable physical and traffic conditions and enabling railroad officials to prognosticate and explain some of the seemingly unaccountable increases and decreases in the cost of operation."

The above quotation clearly explains the object of this work, and in order to accomplish it the subject has been divided up into different items, and each item studied separately in all its effects upon the cost of locomotive operation. These are divided into three general heads, viz.: supplies, maintenance and service. Each of these general heads are divided into individual items. Under the heading of supplies the subjects of fuel, water, lubricants, waste, tools and miscellaneous are taken up separately. Under the heading of maintenance—general repairs, running expenses and renewals are considered, and under the heading of service—engineers, firemen, hostling and turning, cleaning fires, wiping, inspecting and firing-up are investigated. In considering each of these separate subjects it is recognized that the effects and cost of each vary very materially in different sections of the country, and the subject is so handled that the results largely eliminate these differences and can be made applicable to practically any railroad in the country.

The second chapter in the book takes up the subject of fuel, which is a most important item in the cost of operating locomotives, and the effect of each condition in operation is carefully treated. Thus we find what effect the quality of the coal has under different circumstances, in which it is illustrated that it is not always the best coal which will give the cheapest operating cost on certain designs of locomotives. The price is also considered, and it is shown that with the proper design of locomotive a cheap coal can often be made to be less expensive per trip or per ton mile than the higher grade and more expensive fuel. The cost of hauling, handling, loss by shrinkage, storage, etc., are each investigated. The effect of firing, running, design and condition of the power, grades, curvature, speed, tonnage, overloading, acceleration, braking, stopping and weather on the coal consumption and cost are each given careful study, and the results are usually put into curve or tabular form, making them convenient for everyday use.

The third chapter takes up the subject of water, considering its quality, the cost of water treated and untreated, pumping, and in it is carefully considered the value of purified water, showing under what conditions it is cheaper to go to a certain expense to obtain pure water.

The other chapters in the book are each handled in the same detailed manner, and the results is a volume which contains an amazing amount of valuable and useful information, which should be known by all railroad officials in any way connected with the maintenance or operating of locomotives. An index is included, which will assist in making the book convenient as a ready reference.

Economics of Railway Construction. By Walter Loring Webb. Published by John Wiley & Sons, 43 East 19th Street, New York. 324 pages, 5½ by 8¼. Cloth. Price, $2.50.

This book puts in a practical and convenient form much matter on railroad economics which will be of value and interest to a constructing or operating engineer. It does not attempt to go deeply into the theoretical subject, but includes practical matter for the use of the student or railroad man. It is divided into three parts, the first of which consists of the financial and legal elements of the problem, containing chapters on railroad statistics, organization, capitalization, valuation of railroad property and estimation of volume of traffic. The second part consists of the operating elements of the problem, and includes chapters on operating expenses, motive power, economics of car construction, track economics, train resistance and momentum grades. The third part discusses the physical elements of the problem, and includes chapters on distance, its effect on operating expenses and receipts, curvature, minor grades, ruling grades, pusher grades and balancing grades for unequal traffic. The book contains much valuable information put in the form of tables, and the subjects are illustrated by means of curves wherever advisable. Each subject head in the book is numbered, and an index is included for ready reference. The matter is all clearly and concisely stated, and as a whole this volume will be found of value to those concerned in any way with the operation of a railroad.

Management of Electrical Machinery. By Francis B. Crocker, E. M., Ph. D., and Schuyler S. Wheeler, D. Sc. Sixth edition. Cloth, 223 pages, 4½ by 6¼ inches. D. Van Nostrand Company, 23 Murray Street, New York. Price, $1.00.

This book was first published 14 years ago under the title of "Practical Management of Dynamos and Motors," and has twice been completely revised, and many additions, which make its contents timely, have been introduced. For those who desire a handy reference book and source of information for daily use in the operation of electrical machinery this book is especially fitted.

In the first few chapters the authors consider the subject of generators and prime movers from the standpoints of construction, installation and operation. The various methods of connecting generators with the sources of driving power and the proper connections for wiring the various types of generators and motors are considered. Practical information is included regarding such subjects as the balancing of armatures and the installing of various safety devices. The next chapters deal with the details of operation, and give methods for making commercial tests and keeping generators and motors in good operating condition. Such details are considered as the heating of field magnets, bearings, noisy operation, increased speeds, variations in voltage, etc. The latter part of the book is devoted to the description of and suggestions for operating and repairing arc lighting machinery. A chapter which includes a set of questions and answers to assist in localizing and remedying operation troubles is included, and the last few chapters take up the maintenance of railway motors.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

Dayton Pneumatic Tool Co.—This company is issuing a circular illustrating and drawing attention to some of the most prominent features of the Green Pneumatic Hammers.

Chicago Pneumatic Tool Company.—This company is issuing a booklet which includes the names of some of the users of the Franklin air compressor throughout the world, the list being arranged geographically by countries, states, towns and users. It is very extensive and interesting. Although the Franklin plant has been in operation only about three years, during that time it has built and shipped more than 1,000 air compressors, having an aggregated capacity of 500,000 cu. ft. of free air per minute and representing installations of about 8,500 h.p.

Generators.—Bulletin No. 139, which has just been issued by the B. F. Sturtevant Company of Boston, Mass., in its Engineering Series, presents a full line of generating sets driven by direct-connected vertical enclosed engines with forced lubrication. The published list contains 14 sizes, ranging from 3 to 50 k.w. in output; the former driven by a 3½ x 3 engine and the latter by a 12 x 10. All of the engines were especially designed for generator driving.

Steam Traps.—The Joseph Dixon Crucible Company, Jersey City, N. J., publish a very interesting pamphlet on the subject of steam traps. It is an illustrated description of the several varieties, with valuable suggestions by W. H. Wakeman, expert steam engineer and author of well-known books on steam engineering. Some steam users seem to think that a steam trap is only a luxury to be enjoyed by those who have expensive plants in operation and wish to show many extra appliances which might be dispensed with, and not be missed. This is a great mistake, as a trap is valuable according to the cost of fuel that must be burned to make the steam. Certain it is that this pamphlet is well worth most careful reading, for it is instructive as well as interesting.

The Staybolt Subject in Brief.—A pamphlet on this subject is being issued by the Flannery Bolt Company, Pittsburgh, having been prepared by Mr. B. E. D. Stafford, general manager of that company. The subject has been most carefully treated, and is illustrated by interesting sketches and photographs. The points of weakness of the different types of rigid staybolts are pointed out, and the reasons why the Tate flexible staybolt has proved successful are considered. The pamphlet includes much valuable matter about the best material for rigid staybolts and the stresses which a staybolt will stand. The cost is considered carefully both for installing and renewing. This pamphlet contains much valuable information, and will be of interest to all those connected with the maintenance of locomotive boilers.

Electrical Apparatus.—The General Electric Company is issuing a number of publications, one of which is entitled "G. E. Specialties," and is put in convenient form for reference, containing over 200 pages, giving illustrations, brief descriptions and tables of sizes and capacities of a wide array of electric specialties. A detachable price list is included within the same covers. Included in this catalog are many different designs of cabinets for 2 or 3-wire mains and as many outlets as desired for both lighting and power; also circuit breakers, switches, lamp specialties, fuses, insulators, etc. The same company is also issuing a catalog on type H General Electric transformers, which illustrates and carefully describes this type of transformer and its operation. These are made in sizes from 600 to 60,000 watts in practically any desirable voltage ratio. A number of bulletins are also being issued covering the following subjects: Cable terminals; parts of arc headlights, giving reference to catalog number and including prices; variable speed direct current motors with commutating poles; switchboard panels; constant current enclosed arc lamps; polyphase induction motors; GE-78 railway motor, and a careful discourse on the subject of feeder regulators.

Sturtevant High-Pressure Blowers.—The B. F. Sturtevant Company, Hyde Park, Mass., is issuing Catalog No. 140, descriptive of high-pressure blowers. These blowers are designed for handling air or gas at any pressure below 10 lbs. per sq. in., and occupy a position midway between the large low-pressure volume blowers or fans, which for many years past have been manufactured by this company, and the strictly blowing engine or air compressor. They may be used to advantage in supplying air blasts for foundry cupolas, forge fires, smelting furnaces, hardening, tempering and annealing furnaces, for pneumatic tube systems, for moving granular material and, in fact, for any purpose where the maximum pressure does not exceed the limit of 10 lbs. These blowers, which were illustrated and carefully described in the February issue of the American Engineer and Railroad Journal, page 76, are manufactured in a variety of sizes and capacities ranging from 5 cu. ft. to over 15,000 cu. ft. per minute. The catalog thoroughly illustrates and describes all the different details of the blower and carefully explains its operation. A chapter is given on the proper method of installation, and another gives the results of tests made in the foundry, which showed that but 2.45 h.p. was required to liquify each ton of iron, the rate of the melting being 6.65 tons per hour. Another chapter is also given on the use of this blower as a gas exhauster, where it has been

very successful. The next chapter illustrates the blower directly driven by either motors, vertical or horizontal engines, which units are manufactured by the B. F. Sturtevant Company. A final chapter is given on the proper method of testing blowers, and tables are included showing the weight of air under different pressures and temperatures and the flow of air through different size orifices.

CONSOLIDATION TYPE FREIGHT LOCOMOTIVES.—A pamphlet just published by the American Locomotive Company describes and illustrates a large number of consolidation locomotives built for various railroads. This pamphlet includes only consolidation locomotives weighing less than 175,000 lbs., and will be followed shortly by a pamphlet illustrating designs of this type weighing more than 175,000 lbs. The pamphlet opens with a description of the 2—8—0 type, giving its distinguishing characteristics and its special advantages for heavy freight service or service on light rails where the wheel load is limited. Then follow four pages of tables giving the principal dimensions of thirty consolidation locomotives, ranging in weights from 66,000 to 175,000 lbs., the tables being arranged in the order of the total weights of the locomotives. The next two pages show drawings of the side elevation and end elevation of a typical design of consolidation locomotive. The rest of the pamphlet is taken up with photographic reproductions of the locomotives given in the tables, with the tabular information concerning the design on the page opposite each photograph. This is the third of the series of pamphlets which is to be issued by the American Locomotive Company, and will include all the standard types of locomotives, and constitute a record of the production of the company. Copies of the pamphlets already issued on the Atlantic, Pacific and Consolidation types may be had upon request.

NOTES.

WILMARTH AND MORMAN CO.—It is announced that Mr. Corneil Ridderhof, at present treasurer and general manager of the Wilmarth and Morman Co., of Grand Rapids, Mich., has sold his interest in that firm, and will on January 1, 1907, resign in order to undertake a new business.

CORRECTION.—The name Kobbe Company, mentioned in our October issue, should have read The Morse Chain Company, who have recently removed their plant from Trumansburg to Ithaca, N. Y.

BRANCH OFFICE IN CANADA.—The Jeffrey Manufacturing Company, Columbus, Ohio, has established a new Canadian branch office in Montreal, Canada, it being located on Lagauchetiere and Cote Streets.

WATER SOFTENERS FOR SOUTH AFRICA.—The Kennicott Water Softener Company has received through its London office an order for seven water softeners for the Eckstein Group of the Rand Mines, Ltd., Johannesburgh, South Africa.

BOYER SPEED RECORDERS.—The Chicago Pneumatic Tool Company has received orders from the Chicago, Burlington & Quincy Railway for 114 Boyer speed recorders, which are to be applied to the new equipment now being received by that road.

STANDARD SCALE & SUPPLY COMPANY.—This company has recently installed for the Pennsylvania Steel Company at Steelton, Pa., two of the largest railroad track scales ever used east of the Mississippi River, both being of 150 tons' capacity and 46 ft. long.

THE CINCINNATI PUNCH & SHEAR COMPANY of Cincinnati are shipping to the Imperial Steel Works, Modji. Japan, a machine for punching six holes in the standard angle splice bars for 100-lb. rails and a shear for shearing the splice bars to proper length. Both machines are to be driven by General Electric 220-volt direct current motors.

THE T. H. SYMINGTON COMPANY.—This company has secured the services of Mr. C. R. Naylor, who for the past 12 years has been in the mechanical department of the Atchison, Topeka & Santa Fe Railroad. Mr. Naylor will make his headquarters in the Western sales office of the Symington Company, Railway Exchange Building, Chicago.

FARLOW DRAFT GEAR.—In noticing the pamphlet entitled "The Bull Dog of Draft Gears" in our last issue the wording was such as to indicate that the draft spring was so injured as not to be capable of immediate use. That was not the case, however, and the whole gear, including the spring, was in condition to have been applied to another car immediately after the wreck.

ELECTRIC CONTROLLER & SUPPLY COMPANY.—This company announces the opening of a Chicago office in the Merchants' Loan & Trust Building, 135 Adams Street, Chicago, which has been placed in charge of Mr. W. N. Connelly, who has had long experience in the electrical field.

HEATING APPARATUS.—Among the recent installations of heating apparatus made by the B. F. Sturtevant Company, Boston, Mass., are found the following railroad shops: The repair shop of the New York Central at West Albany, the roundhouse of the Southern Railway at Greenville, the new erecting shop of the American Locomotive Company at Schenectady and the Haskell & Barker car shop at Michigan City.

PURDUE UNIVERSITY.—This university entered upon its 33d year on September 12th, and at the end of the second week 1,588 students had been enrolled, of which 86 per cent., or 1,379, were registered in the schools of engineering. The facilities of the engineering department have been considerably increased by the addition of new buildings and equipment during the past year, and a number of additions have been made to the instructing staff.

LARGE ELECTRICAL SHIPMENTS.—The Crocker-Wheeler Company, Ampere, N. J., have within the last few weeks, in addition to all smaller shipments, sent out nine carloads of electrical machinery, of which four carloads of motors went to the National Tube Company, two of generators and motors to the Lehigh Portland Cement Company, two of alternating current generators to the Snow Steam Pump Company and one of small motors to San Francisco.

CHICAGO PNEUMATIC TOOL COMPANY.—A largely increased demand for the Franklin air compressors has made it necessary for the Chicago Pneumatic Tool Company to make very substantial additions to the Franklin plant, and in addition to the extensive improvements which have been made in this plant, during the current year, it has now become necessary to add 150 ft. to the machine shop, which will permit an increase in output from 35 to 70 compressors per month.

SMALL VERTICAL HIGH-SPEED ENGINES.—The May issue of the Journal of the Association of Engineering Societies contains an article by Mr. F. R. Still, a member of the Detroit Engineering Society and chief engineer of the American Blower Company, on "Small Vertical High-Speed Engines." This article, which is illustrated, explains the difficulties attending a satisfactory design of small high-speed engines, and explains how they have been overcome and corrected. It contains much interesting and valuable information.

NEW IRON AND STEEL COMPANY.—The Refined Iron & Steel Company, Pittsburgh, announces that their plant is now completed and in operation, and is producing high-grade puddled iron for various uses. A specialty is being made of staybolt iron manufactured by a process controlled by Mr. Stubblebine, who is the manager of the Company. Mr. Stubblebine has previously for 35 years been superintendent of the Bethlehem Rolling Mills, and with his son, who is superintendent of this plant, has had a long experience in the iron business. The equipment in operation consists of seven puddling furnaces, three heating furnaces, a 22-in. puddle train and a 16-in., 12-in. and 9-in. train of rolls. The president of the company is Mr. J. C. DeNoon; the vice-president. Mr. I. N. DeNoon, and the secretary is Mr. Harry F. Gilg.

STANDARD ROLLER BEARING COMPANY.—Mr. S. S. Eveland. vice-president and general manager of the Standard Roller Bearing Company, Philadelphia, has purchased for that company the entire plant of the Pennsylvania Iron Works Company, which joins their present property. By this purchase they have secured five extra buildings and real estate 1,600 x 120 ft., all on the main line of the Pennsylvania Railroad, which makes the total length of their property over one-half mile. In addition to the above, this company is also erecting the largest reinforced concrete building in Philadelphia or vicinity, which will be devoted exclusively to the manufacture of annular ball bearings, automobile axles. etc. Over 1,200 hands are employed at the present time, and this number will eventually be raised to over 3,000 when building and alterations now under way are completed. During the past few months this company has built and equipped a large crucible steel castings plant, and iron and brass foundry and a large drop forging plant. They now have the largest complete plant in the world for the manufacture of automobile axles and ball and roller bearings.

(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

DECEMBER, 1906.

BETTERMENT WORK ON THE SANTA FE.

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PART I.—GENERAL.

Object.

During the past two or three years a remarkable work has been going on in the motive power department of the Santa Fe System. Starting with a systematic effort to improve the condition of the machinery and equipment, the centralization of manufactured material and the introduction of the individual effort method or bonus system at the Topeka locomotive repair shops, the "betterment work," as it is called, has gradually been extended throughout the motive power department over the entire system. The purpose of this article is, as briefly and clearly as possible, to consider the results which have thus far been accomplished and to trace the development of the work.

The betterment work was started in May, 1904, at the time of the machinists', boilermakers' and blacksmiths' strike. The objects of this work, in the order of their importance, were:

(1) To restore harmonious and cordial relations based on mutual respect and confidence between employer and employe.

(2) To improve the condition of the worker and give the company more reliable and trustworthy employes.

(3) To increase automatically and without fixed limit the pay of good men; this increase of pay depending on themselves and not on their immediate superiors.

(4) To increase the capacity of the shops without adding new equipment.

(5) To increase the reliability of the work turned out or the efficiency of the operations performed.

(6) To do all these things not only without cost to the railroad company, but with a marked reduction in its expenses.

The prime object, therefore, was to increase the efficiency of the mechanical department, although, as indicated by the last clause, it was expected that economy would follow as a natural result.

The betterment work has been carried on under the general direction of Mr. J. W. Kendrick, second vice-president, by Mr. Harrington Emerson, counselling engineer, in co-operation with the motive power department under Mr. A. Lovell, superintendent of motive power. The hearty co-operation of the accounting department under Mr. W. E. Bailey, general auditor, of the purchasing department under Mr. W. E. Hodges, general purchasing agent, and of the store department under Mr. N. M. Rice, general storekeeper, has materially assisted in making possible the remarkable results accomplished.

The Santa Fe System and the Organization of the Mechanical Department.

The Santa Fe System covers 8,500 miles and operates 45,347 cars, of which 44,204 are freight cars, 995 are passenger cars and 148 are miscellaneous. It has 1,633 locomotives.

The motive power department is in charge of Mr. A. Lovell, superintendent of motive power, and is divided into five mechanical divisions as follows:

(1) Eastern Grand—Chicago to Newton. Mechanical superintendent, W. F. Buck; 2,600 miles, 584 engines.

(2) Western Grand—Newton to Albuquerque and El Paso. Mechanical superintendent, M. J. Drury; 2,650 miles, 430 engines.

(3) Coast Lines—Albuquerque to San Francisco. Mechanical superintendent, S. L. Bean; 1,800 miles, 367 engines.

(4) Gulf Lines—Shawnee, Okla., to Galveston. Mechanical superintendent, P. T. Dunlop; 1,450 miles, 252 engines.

(5) Topeka Shops—General repair and manufacturing shop of the system. Superintendent of shops, John Purcell.

The map on the following page will give those who are not familiar with the Santa Fe an idea of its great extent and the territory covered by the various divisions of the mechanical department.

The Topeka shops are the largest on the system, the superintendent of shops reporting directly to the superintendent of motive power. The other shops are under the master mechanics upon whose division they are located.

Outline of the Betterment Work.

It was believed that the objects stated above could best be accomplished by increased supervision and special reward to the workmen. Increased supervision was to be aided by a more frequent and prompt tabulation of the various performance records and by special expert investigations of every operation, as to the man, machine methods and material, with consequent planning to eliminate wastes of every kind. The work was limited to the maintenance accounts and to locomotive operation in its various phases, repairs, roundhouse work, supplies, fuel consumption, failures, lessening of delays in the shops, adjustment of repair activity to traffic needs, etc. This extensive work was, of course, taken up gradually and locally, and as will be shown later is only in partial operation at the present time.

From May, 1904, to October, 1905, the work was confined to the Topeka shops, and first consisted in the rebuilding and remodeling of many machines, in the concentration of manufacture of materials, especially of tools at the Topeka shops, and in the starting and establishing of the individual effort reward system.

The betterment work was extended to different parts of the system and to include various features as follows:

Oil-burning on locomotives, March, 1905.
General tool account for the system, August, 1905.
Topeka roundhouse, September, 1905.
Albuquerque shops, November, 1905.
Raton and Winslow, January, 1906.
Shopton (Illinois Division), January, 1906.
San Bernardino shops, Coast Lines, February, 1906.
General roundhouse work, April, 1906.
Cleburne shops, May, 1906.
Car work on the system, August, 1906.

In addition power house conditions are being investigated and improved. The matter of engine equipments is being studied and abuses corrected. Engine performances on different divisions and on the system as a whole are being followed

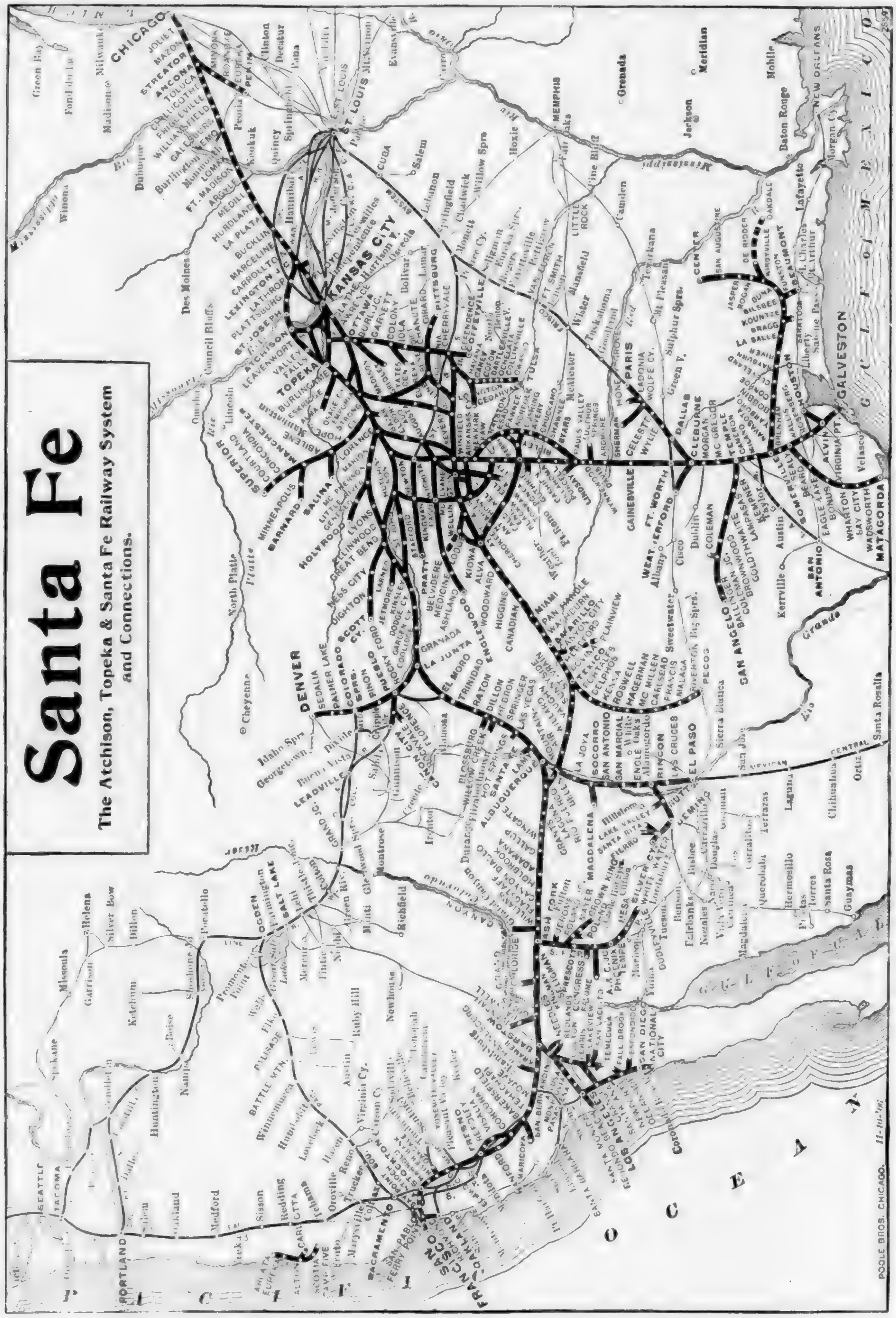


FIG. 1.—MAP OF THE SANTA FE SYSTEM.

up by graphical records which show at a glance the exact condition as compared to previous records. The same thing is being done with the mechanical department payrolls.

General Results.

Thus far the betterment work on the Santa Fe has materially assisted in restoring harmony between the employer and employe, and in greatly increasing the efficiency and reliability of the worker. His wages have been increased on an average of from 10 to 20 per cent.

As has been stated, the prime object of the betterment work was to increase the efficiency of the mechanical department, and while it was expected that economies would naturally result, the following study, based upon the president's reports for the fiscal years of 1905 and 1906, while, of course, only approximate, shows conclusively the value of the betterment work in this respect; this, too, in spite of the fact that much of the betterment work on the system as a whole was not started until the fiscal year of 1906 was more than half gone

and has not even as yet been fully installed. In order to check the results and possibly bring them out more clearly the figures in the president's reports for 1905 and 1906 will be examined from several viewpoints.

* * * * * * * * * * *

The president's reports cover the fiscal year beginning July 1st and ending June 30th.

SAVINGS FIGURED ON AN ENGINE BASIS.

	1904-5.	1905-6.
Total number of engines June 30th	1,454	1,633
Reduction in cost per engine, including all renewals, distributed and adjusted charges		$1,064.07
Total economy on 1,633 engines	$1,737,626	
Average engines in service	1,447	1,550
Reduction in cost per engine as above		$918.15
Total economy	$1,423,132	
Reduction in cost, actual charges for repairs only to account 12, engines, and account 17, tools and shop machinery		$795.49
Total economy	$1,233,009	

This last figure is based on engines actually in service, and with the exception of maintenance of shop machinery and tools does not include renewals, supervision, boiler service or other adjusted and distributed expenses.

* * * * * * * * * * *

SAVINGS FIGURED ON A MILEAGE BASIS.

	1904-5.	1905-6.
Engine mileage	40,727,636	45,694,524
Increase 1905-6 over 1904-5		4,966,888
Per cent. of increase		12.2

Direct reduction of cost per engine mile, not including renewals or distributed accounts:

Labor	$0.0225
Material	$0.0068
Total account 12	$0.0293
Account 17	$0.00386
Total reduction	$0.03316

Had the cost per mile been as high as in 1904-5 the additional cost would have been:

For account 12	$1,338,850
For account 17	176,809
	$1,515,659

The actual cost of supervision increased from $367,555.94 in 1904 to $446,287.54 in 1905-6. This was an actual increase of $78,731.60, but reduced to a basis of mileage the increase would be only $33,813.95 greater than it would have been if the cost per mile had been the same for 1905-6 as for 1904-5. The miscellaneous expenses, which also include the expenses of power house and water service operation, were reduced from $817,055.79 in 1904-5 to $563,536.94 in 1905-6. The actual decrease in this item, therefore, amounted to $253,518.85, although if reduced to a mileage basis the reduction would amount to $353,218.67, part of which was due to betterment work. The saving based upon the cost per mile would, therefore, agree quite closely with the results derived from the total cost per engine.

* * * * * * * * * * *

Assuming that the repairs are proportional to the fuel used, the above figures may again be checked:

	1904-5.	1905-6.
Coal used, tons	1,910,845	2,101,906
Fuel oil used, tons	525,005	604,340

Equating the fuel oil on a basis of 60 lbs. of oil to 100 lbs. of coal, the tons of fuel burned in 1904-5 would be 2,784,245, as compared to 3,108,000 for 1905-6. On a fuel basis of 1904-5 the locomotive repairs for 1905-6 should have been $1,308,650 greater, and the tool account would have been $155,400 greater, making a total saving of $1,654,050 if we assume that the greater cost of supervision is offset by the saving in the general expense account due to the betterment work.

* * * * * * * * * * *

On the Santa Fe a road unit is equal to the engine mileage multiplied by the weight on drivers in pounds divided by one hundred million. The cost for 1905-6 based upon the cost per road unit for 1904-5 would be:

	1904-5.	1905-6.
Total road units	47,855	56,301
Road unit cost	$106	$78
Saving on basis of 1904-5:		
Locomotive repairs	$1,618,091	
Tool account	204,936	
Total	$1,823,027	

* * * * * * * *

Checking the figures on the basis of number of tons on drivers, we find the following:

	1904-5.	1905-6.
Tons on drivers	85,421	100,054
Saving on basis of 1904-5:		
Locomotive repairs	$1,591,859	
Tool account	202,109	
Total	$1,793,968	

* * * * * * * *

The store department by a careful and systematic effort over the entire system reclaimed and put into use a large amount of material, and effected a considerable saving in the figures of 1906 as compared with the previous year. Nevertheless, the saving due to the advice and methods of the betterment department, put largely into effect through the regular mechanical officials, could probably on the most conservative basis be placed at a million and a quarter dollars. This is a remarkable showing, especially as a large part of the work was started too late in the year to have any appreciable effect upon the annual report.

General Methods.

In undertaking a work as large and far-reaching as that of the betterment work on the Santa Fe there are a few general principles which must be kept ever in mind and be closely adhered to. The men in charge of such work must overlook the situation from a broad viewpoint, and must not be misled by details.

Such success as has been attained is due largely to the inculcation of principles and the modification of practice to agree with principles. A pertinent illustration is the treatise entitled "Shop Betterment and the Individual Effort Method of Profit Sharing," which was prepared by Mr. H. Emerson and with the approval of Mr. J. W. Kendrick and Mr. A. Lovell distributed among the employes of the mechanical department of the Santa Fe, and was reprinted on page 61 of our February, 1906, issue. The words placed at both the beginning and end of this treatise are worthy of repetition: "Fairness not favoritism, efficiency not drudgery, and individuality not subserviency."

Mr. Emerson lays special stress on the importance of having records and not reports to indicate what is actually being accomplished, and all his assistants are instructed to base their work on records, and if these are lacking to begin work by making them. A report is usually based upon exceptionally good showings that have been made, but a record to be truly valuable should be based upon the average work that is being done. The exceptionally good record has a value, of course, in that it gives an ideal point which we should strive to reach.

To avoid errors and to give the greatest possible authority and weight to the figures used four principles are followed:

First—Official figures only, if in existence, are used. If there are no official figures, use the most reliable records obtainable until official figures can be supplied.

Second—As comprehensive figures as possible are used.

Third—Each statement should cover not a single month, but the average of at least a year. This is done by averaging in each month a whole year of records. For instance, instead of saying this is a record of December, 1906, the statement takes this form: This is the rate or monthly average for the year ending December 31, 1906.

Fourth—Use an attained practical minimum as a standard to which to work.

The accompanying engine performance diagrams (Figs. 2 and 3) illustrate nicely the third and fourth clauses as stated above. The record for each month is averaged with the eleven preceding months. No spasmodic or special effort for a single

month will greatly change the direction of these lines. Only a steady improvement extending over a considerable period of time will materially affect their direction. The differences due to changes of seasons or accidents are also eliminated, and the lines show clearly the actual tendencies. The repairs are based on the amount of fuel burned, thus eliminating differences due to grades, seasons and special conditions, as these features affect similarly both the fuel and the repairs. As a locomotive is a machine for converting the energy of coal into work at the draw bar, it is evident that work done should vary directly with coal burned. Repairs should vary with work done. Therefore dollars of repair, per ton of coal, gives us a unit of comparison in which variation of grades, speed, etc., can be ignored. The coal used on mountain divisions is greater than that used on the plains. The repairs are also greater, but the work done is also greater and the ratio of dollars of repairs to tons of fuel remains surprisingly constant.

This ratio does not, of course, show as strikingly as it

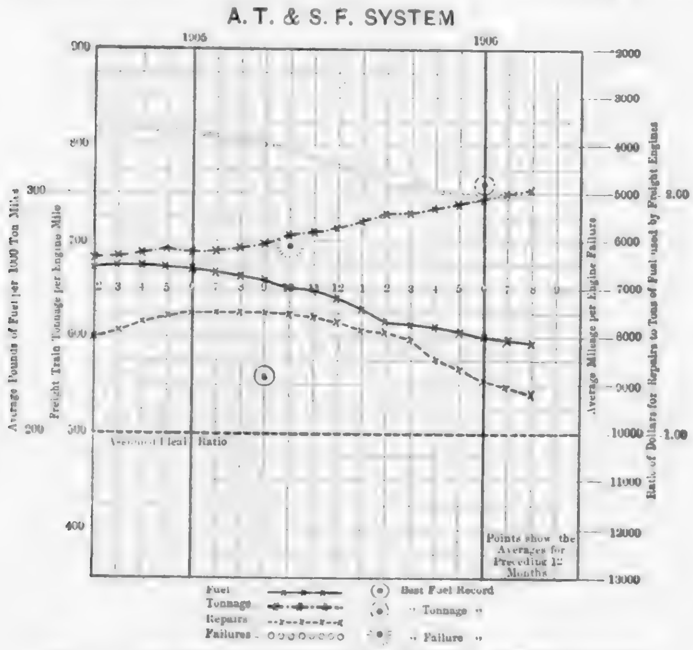


FIG. 2.—GRAPHICAL RECORD OF ENGINE PERFORMANCES, A., T. & S. F. SYSTEM.

would if otherwise plotted, the great reduction made in the cost of repairs, since due to careful and systematic efforts the amount of fuel burned per 1,000 ton miles has been decreased considerably during the past year. As may be seen, however, the cost of repairs has been reduced in even a greater ratio. It is interesting to note that as the matter of locomotive repairs has been given greater attention the number of engine failures has gradually but surely decreased; the average freight train tonnage per engine mile has steadily increased, and the average pounds of fuel per thousand ton miles has steadily decreased. Three points will be noticed on the diagrams, one showing the best fuel record, one the best tonnage record, and one the best record for miles run per engine failure. These points show the best records for any one month during the time covered by the diagram and furnish ideal points to work too. The assumed ideal ratio for the cost of repairs to tons of fuel used by freight engines is $1 to each ton of fuel. This record has actually been accomplished on some few of the other railroads, and on some divisions on the Santa Fe the line shown on the diagram has already been passed and there appears to be little question that the Santa Fe System as a whole will eventually reach this point. The first diagram is for the Santa Fe System as a whole, and the second (Fig. 3) is for the Eastern Grand Division. It will be seen that on the Eastern Grand Division the above standard for repairs has not only been attained, but that for a considerable period the cost of repairs, per ton of fuel used, has been less than the ideal. Diagrams similar to the ones shown are drawn up for each district and sent out every month. Each master mechanic is therefore stimulated to censure fuel waste and to lessen repair waste.

This same method applied to other records makes it possible intelligently to analyze conditions and to locate and correct the weak points.

As various facts indicating wastes or opportunities of improvement are reported to Mr. Emerson's office, all the conditions are investigated and new methods are, as the case may require, considered in conference with the general auditor, with the general purchasing agent, with the superintendent of motive power, with the general statistician, with the general storekeeper, with the superintendent of the shops and the mechanical superintendents, or general managers. When an agreement has been reached and there is need for final authoritative action, the desired changes are submitted to the second vice-president for final approval. This adopts and incorporates the modifications due to special work into the regular departments effected by these modifications.

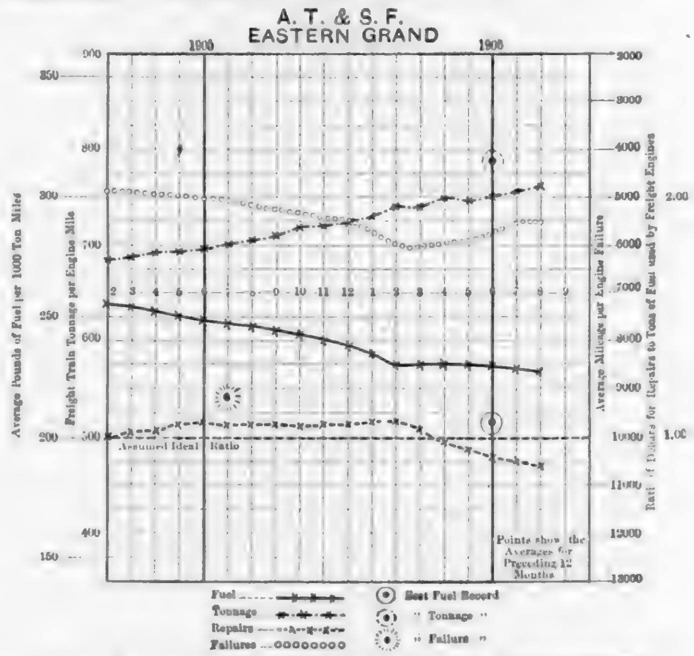


FIG. 3.—GRAPHICAL RECORD OF ENGINE PERFORMANCES, EASTERN GRAND DIVISION.

As examples of this co-operative work the following are cited:

(1) All mechanical pay rolls and distribution are reported daily by the mechanical auditors.

(2) Specifications as to many supplies have been adopted by the general purchasing agent.

(3) The superintendent of motive power has approved recommendations for standardizing tools and engine parts, and other innumerable recommendations.

(4) The general statistician has put into effect a monthly report of locomotive performance, and has given valuable compilations and comparisons from other railroad systems.

(5) The general storekeeper has always immediately adapted his own department procedures and records to the often annoying experimental changes, and he has directed all division storekeepers to co-operate in every possible way.

(6) The superintendent of the Topeka shops, while never abdicating his position as head of these shops, has after conference and mutual agreement put into effect locomotive, gang and machine schedules, has himself introduced the new methods into the blacksmith and other departments, etc.

(7) The mechanical superintendents have co-operated as to roundhouse and car work and as to the smaller shops.

(8) General managers have seconded efforts and carried out recommendations as to power house betterments, and as to fuel and supplies for locomotives.

Records of payrolls, engine repairs, engine mileage, engine failures, engine tonnage, engine fuel consumption, engine supplies, of tool and machinery repairs, of car deten-

tions and repairs are sent regularly to Mr. Emerson's office, and there tablulated and graphed so as to show promptly and in the plainest manner the general tendency over the entire system, giving as it were in a single glance a comprehensive "bird's eye" view of maintenance, shop, engine, car, fuel and supply conditions of the system as well as of each individual point.

The method as a whole has been to collect facts, to investigate and evolve remedies, to adapt them to the experience of regular officials, to entrust the application of remedies to the regular officials, and occasionally and only temporarily lending a hand. The regular graphed records permit of keeping in constant touch with what is going on.

When vacancies have occurred and promotion was being considered these graphical records of individual performance have been carefully considered by the higher officials. Three of the four mechanical superintendents have been promoted to their present positions since January, 1906, and in each case the promotion was made on records previously tabulated in graphical form. The records had, in fact, selected these men for promotion before vacancies occurred:

Organization of the Betterment Department.

Mr. Harrington Emerson, counselling engineer, has general charge of the betterment department, and is also the local resident for Topeka shops and the Eastern Grand Division problems. Mr. Emerson is assisted by Mr. Clive Hastings, formerly of the Northern Pacific Railway. The work carried on in Mr. Emerson's office is of a general character. Methods are evolved in co-operation with the auditing department to secure freely and promptly records of payroll accounts, distribution, etc. The reports from the entire system as to tools, locomotive output, cost of repairs, fuel and tonnage performances, failures, mechanical payrolls, etc., are tabulated and graphed, and mechanical superintendents are advised of the results on their divisions.

The special men directly connected with the betterment work and reporting to Mr. Emerson are: Mr. H. W. Jacobs, formerly of the Burlington and the Union Pacific. He is territorially in charge of all betterment work on the Coast Lines and functionally in charge of the tool and machinery betterments for the system. His title is engineer of shop methods and tools, and to his experience and skill are largely due the betterments of shop machinery, the standardization of tools, etc., with consequent reductions of cost. At San Bernardino, California, marked reductions in expense and marked increase in output followed the introduction of betterment methods under Mr. Jacobs' directions.

Mr. H. E. Muchnic assists Mr. Jacobs at Topeka in connection with the tool and machinery betterments.

Mr. J. E. Epler, formerly of the Burlington, the Delaware, Lackawanna & Western and the Vanderbilt Lines, is territorially in charge of betterment work on the Gulf Lines and functionally in charge of all car work.

Mr. S. D. I. Emerson is in charge of the betterment work on the Western Grand Division, and with him is associated Mr. W. J. Power, formerly of the Union Pacific. Mr. Emerson and Mr. Power, before going to the Western Grand Division, were in charge of the time studies and bonus schedules and of the introduction of individual effort methods at Topeka.

Mr. J. F. Whiteford, formerly of the Burlington and the Union Pacific, is in charge of all betterment work as applied to roundhouses.

Mr. Curtis B. Goode is in charge of power house economies.

Mr. Thomas W. Neely is in charge of oil-burning economies.

Mr. F. L. Hutchins, formerly of the Boston & Maine, is in charge of records and graphs.

Mr. G. S. S. Playfair was at Shopton and in charge of road unit records.

Mr. E. K. Wennerlund is general assistant on the A., T. & S. F. Proper.

Under Mr. Jacobs, Mr. R. Emerson has special charge of account 25, supplies to locomotives.

In addition each of the above has his own assistants, the total number of men directly engaged on this work in October being 31.

PART II.—DEVELOPMENT AND SPECIFIC RESULTS.

Belting.

The first work undertaken by the betterment department, May to October, 1905, was confined to the Topeka shops, and consisted in improving the efficiency of the shops and establishing the individual effort reward system. One of the first things considered in connection with improving the efficiency of the machine tools was that of belting. Investigation developed the fact that the time lost on the various machines due to belt failures was a very serious item, and the expense of maintaining the belting, which was given about the same attention as in the average railroad shop, was excessive.

As may be seen by the accompanying diagram, Fig. 4, the belting expense at the Topeka shops alone amounted to about $1,000 per month, with 300 failures, when the work was undertaken in 1904. The installation and maintenance of belting was placed in the hands of a specialist, with instructions to prevent failures, not remedy them, and only the best quality of material was used for repairs and renewals. An inventory was made of every belt in the shop, and an accurate record kept of its performance on a form similar to that shown in Fig. 5.

Knowing that the best practice indicated that the cost of

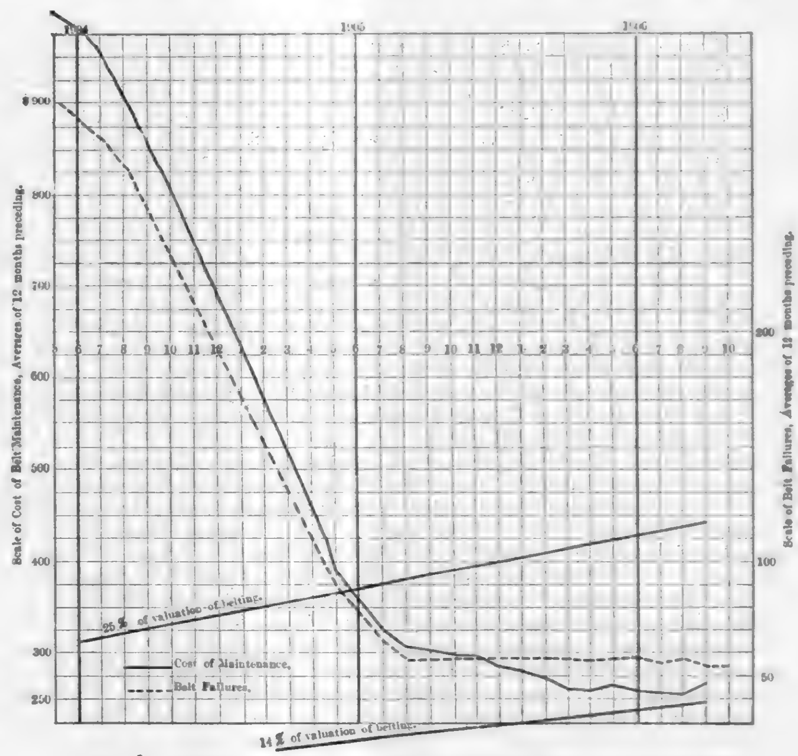


FIG. 4.—RECORD OF COST OF BELT MAINTENANCE AND FAILURES.

maintaining belts, including labor, supplies and belting, should yearly average about 14 per cent. of the first cost, and taking into consideration the fact that much of the belting was not of the best grade, had been in operation for years and was running under unsatisfactory conditions, it was decided to set the ideal to work too, at 25 per cent., with the intention of finally reaching 14 per cent. as conditions were improved. The diagram clearly shows the results accomplished. The expense has been decreased from $1,000 to about $275 per month, the failures from 300 to about 55 per month.

A belt room, about 10 by 35 ft., was fitted up with a complete outfit for repairing belts. The belt foreman also has charge of oiling and of abrasive wheels.

For general service the Jackson or machine lace is used. When a belt is first installed a take up piece 6 ins. long is

inserted. As the belt stretches this piece may readily be removed by withdrawing the two rawhide pins and a shorter piece inserted to take its place. Various lengths of these take up pieces are kept in stock (Fig. 6), and it is a matter of only a few minutes to put in a shorter piece and properly adjust the belt.

The fact that the most expensive material is often the cheapest is strikingly illustrated in this instance, and the following specifications for belting on the Santa Fe are of interest in this connection:

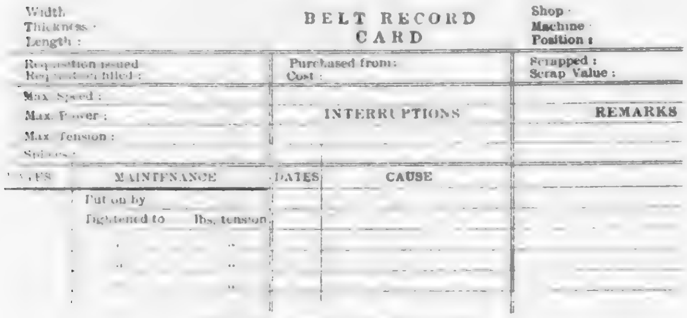


FIG. 5.—BELT RECORD CARD.

Specifications for Belting.

Belting must be of the best oak tan, first quality leather, strictly short lap stock, cut within 18 ins. of the center of the hide and no piece running over 4 ft. 6 ins. long; tanned under the long time process, absolutely free from acids or other ingredients for quickening the tannage or increasing the weight.

Belting must be of uniform thickness and width, and will be inspected at destination. Any belting showing uneven thickness or width or flabby soft spots will be rejected and must be replaced at once, without cost to the Railroad Company.

All belts must have a tensile strength of not less than 4,200 lbs. per sq. in., in either the leather or the splice, and show elongation of not over 12.5 per cent. in 2 ins., 1 in. either side of the break, or less than 8 per cent. elongation at breaking strain.

Any double, triple or quadruple belt which starts to crack or give way between the layers comprising the belt before reaching a tensile strength of 2,500 lbs. per sq. in. will be rejected.

All belting will be furnished in three grades, as below:

Heavy, weighing 17 to 19 oz. per sq. ft.
Medium, weighing 15½ to 16 oz. per sq. ft.
Light, weighing not less than 14 oz. per sq. ft.

The above weights are guaranteed to be no more than 10 to 13 per cent. above the actual weights of the leather after treatment by gasoline, or other process, to remove any stuffing or filling.

All belting must bear the manufacturers' brand and name on every 10 ft. of belting.

All belting, when received at destination, will be laid out flat to its full length, and must lay in a straight line from end to end, both edges of the belt lying flat upon the floor.

Guaranty.

If the belt as received does not in every particular comply with the above specifications it will be rejected, and replaced by the seller without expense to the Railroad Company.

It is further guaranteed that the belting will run practically straight and not stretch, to trouble where shafting and pulleys are right and care has been used in placing it upon them.

To more clearly indicate the systematic way in which the belting question was handled, thus showing the careful investigation and treatment of details by the betterment department and giving a general idea of the methods pursued by them, the following extracts are reproduced from the "Rules and Instructions for Belt Repairmen" compiled by Mr. Emerson for use on the Santa Fe:

Cement Splices.—The first thing to be noted in making a cement splice is to see that the pieces put together are of about the same grade, width and thickness, and that the splices line in the same direction in the same belt. Splices should be made of the length given in the table:

Width of Belt.	Length of Splice.
1 in.	5 ins.
2 ins.	5 ins.
3 ins.	6 ins.
4 ins.	6 ins.
5 ins.	7 ins.
6 ins.	8 ins.
7 ins.	8 ins.
8 ins.	9 ins.
9 ins. to 18 ins.	Same length as width.
Over 18 ins.	18 ins.

Splices should be worked down to a perfectly smooth, even surface, square with the edge of the belt both at the point and back. Care should be taken that the splice is no thicker than the rest of the belt. If the splice is thick the belt will not run even. Square both ends of the splice from the same edge of the belt. Work on a perfectly smooth, flat surface. After dressing the ends for the splice, place them together on a board 1 in. longer and ½ in. wider than the splice. Place the edges from which the splices are squared in a perfectly straight line. Tack the belt to a board, just back of the splice. Open the splice and spread on hot glue, place another board on top of the splice and clamp tightly with hand clamps or in a press. (An old letter press makes an excellent belt press.) If a press is used, ten minutes is long enough to keep pressure on the belt, but if hand clamps are used they must be left on for three or four hours. In either case the belt should not be put under tension for at least five hours after gluing. Paper placed between the boards and the belt will prevent the belt from becoming glued to the boards.

Greasy belts should be cleaned in gasoline before attempting to cement them. Any grease in the belts or glue is liable to cause the splice to fail. No rivets, wire pegs, or any other fastenings aside from cement should be used in splicing belts. Ordinary furniture or patternmaker's glue is satisfactory for belting.

Width of Belting.—A pulley should be 25 per cent. wider than the belt running on it. This rule should be followed as closely as possible, and especially with cone pulleys.

Tension and Thickness of Belts.—Belts should have a tension when at rest of about 100 lbs. per sq. in. of width of good double belting. If not practical to measure the tension on the belt, make the fit length 1 in. per 10 ft. less than the tape-measured length over the pulleys. A steel tape should be used. Great care should be taken to prevent the running of too tight belts and consequent burning of bearings.

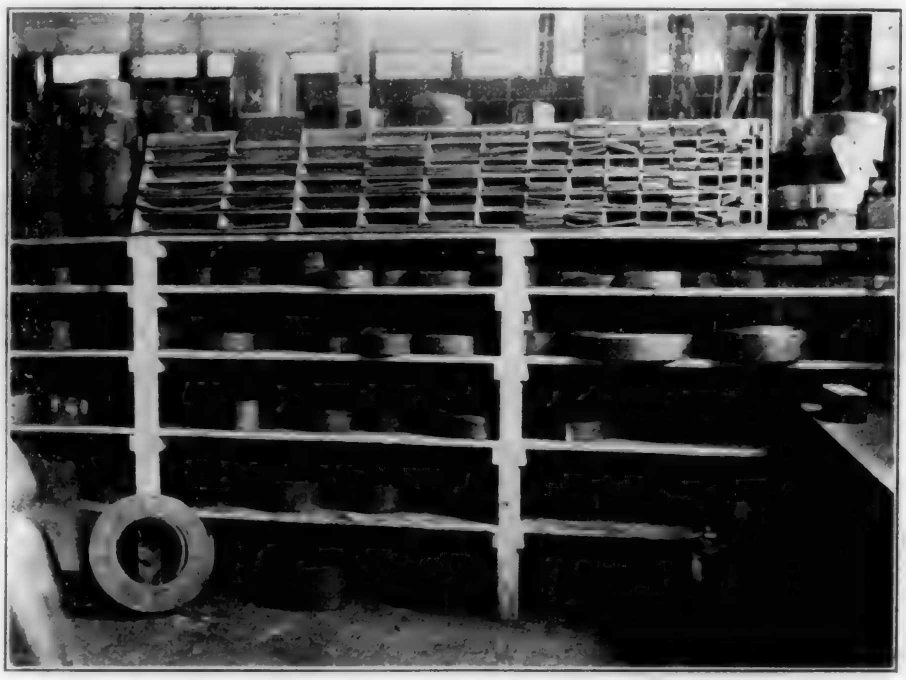


FIG. 6.—CORNER OF BELT ROOM SHOWING STOCK OF "TAKE UP" PIECES AND BELTING.

Double belts should not be run on pulleys less than 6 in. in diameter, and triple belts on pulleys less than 20 in. in diameter. Belts should sag onto the pulleys and not away from them. Very short drives (belts under 20 ft. long) should be avoided. Whenever possible, run up-and-down belts on a slant, so that the belt will sage onto the pulley.

For each horsepower to be transmitted allow 80 sq. ft. of double belt to pass over the pulleys per minute; allow 160 sq. ft. of single belt, or 1,000 lineal ft. of double 1 in. belt, or 2,000 lineal ft. of single belt.

Kind of Lace to Use.—For general service, the Jackson lace should be used, and new belts should have a 6-in. take-up piece put in them to permit the tightening of the belt by putting in a shorter piece, and thus avoiding the need of taking the entire belt down. Belts with Jackson lace should have a take-up piece in them at all times. Pieces should be kept in stock in sufficient numbers to avoid the necessity of making one in an emergency. The lengths should be 6, 5, 4, 3, 2, and 1 ins.

The Kerr lace may be used to hold very thick belts and small feed belts which the Jackson lace will not accommodate.

The rawhide lace may be found by trial to give better service on some woodworking machines than either the Jackson or Kerr laces, but it is generally best to make the belt endless, if neither Kerr nor Jackson lace give satisfaction.

SIZES	Symbol
½" x 1" x 8"	C 102
⅝" x 1¼" x 8½"	C 103
⅝" x 1⅜" x 8½"	C 104
¾" x 1½" x 9"	C 105
¾" x 1¾" x 9½"	C 106
⅞" x 1¾" x 10"	C 107
1" x 2" x 12"	C 108
1½" x 2½" x 13"	C 109

FIG. 7.—HIGH SPEED STEEL LATHE SIDE ROUGHING TOOL AND SYMBOL NUMBERS FOR ORDERING.

Endless Belts.—All machines furnished with any means of taking up the stretch should have endless belts. Large overhead drive belts (over 6 ins. wide) should be made endless as soon as the stretch is taken out. It is not advisable to make new endless belts at installation on account of the stretching. Woodworking machinery having belts which do not require too frequent tightening will run better with endless than laced belts. Side and bottom head belts on planers, matchers, etc., should be run endless.

Cleaning and Oiling.—Belts which have become too greasy and dirty should be cleaned in gasoline, then scraped and wiped with waste. In dry, dusty places it is well to brush them occasionally with a broom or stiff brush.

No rosin or belt dope should be used except fish oil and tallow mixed in equal parts. Apply hot with a brush when the belt is running, or dip the belt in the dope tank, then dry and wipe off any grease which may have hardened on the belt. If applied while running, care should be taken not to get too much on the belt or it will cause it to slip. When properly applied, the mixture of fish oil and tallow will make the belt pull better than any of the commercial dressings. No mineral oil should be allowed to come in contact with the belt. New belts should be treated with fish oil and tallow before using, and any belt which becomes dry, hard and glossy in service should have an application of the dressing. This is especially true of belts in blacksmith shops. The oil will check to some extent the evil effects of the smoke, sulphur gases and dirt, and the life of the belt will thereby be lengthened.

	SIZE
T 102	½ x 1" x 8
T 103	⅝ x 1¼ x 8
T 105	¾ x 1½ x 9

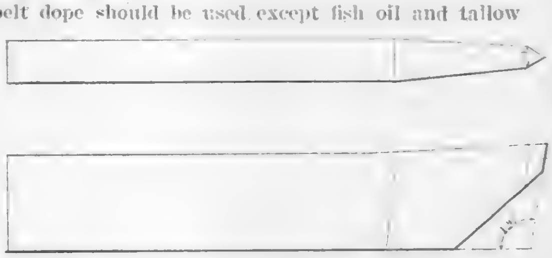


FIG. 8.—STANDARD STRAIGHT THREADING TOOL AND SYMBOL NUMBERS FOR ORDERING.

Inspection of Belts.—Close attention should be given to the condition of the belting to prevent damage to it and delay to the machines. Such delays can be reduced to a minimum by making repairs as soon as weakness develops. Main drive and section belts should be watched very closely, since a failure of one of them may shut down a number of machines for a considerable length of time.

Operation of Belts.—The most essential thing to the successful operation of belts is that pulleys and shafting be properly lined and in good repair. It is bad practice to throw a pulley out of line to favor a bad belt. Belts should be run with the hair side to the face of the pulley. Run the belts so that the outside point of the splice trails. This will avoid opening of the splice by the action of the air. Belts should never be run twisted or cross-stepped on cones.

Keep the pulley clean and avoid having mineral oil or grease come in contact with the belts. If hard grease or dirt is allowed to pile up in the corners of the cones, so as to form a fillet, the belt will be very likely to climb, turn over or twist. In turning the faces of the cones a clearance should be cut in the corners. A drive pulley carrying a shifting belt should never have a crown. In throwing belts onto the pulleys, first put the belt on the driven pulley (loose, if there is one) and then run it onto the driving pulley. Avoid accidents by stopping the motor or engine, and then run the belt on while starting slowly.

Care should be taken never to run a belt off a moving pulley onto some part of the shafting or machinery on which it might catch. If necessary to cut a belt down, care should be taken not to waste the leather.

A belt should never be dampened in order to open the splice. An awl should be used, gradually scratching or ripping the splice apart.

It is good practice to remove the tension from the belts by lifting idlers, running off of pulleys, or removing from the machine, when convenient, at quitting time. All cone and other machine belts should be run off of the pulleys at quitting time on Saturdays.

Tools and Machinery.

The next step taken was to improve the efficiency of the shop machinery and tools. Each machine tool was carefully examined, and in many instances it was found necessary to redesign and strengthen certain parts in order to properly adapt the tools for the use of high-speed steel and the improved methods which it was proposed to install. Cast iron pinions and gears were in many instances replaced with steel. Cone feed pulleys were increased in size to accommodate heavier feeds. Cone pulleys were redesigned to take larger belts and transmit more power. The countershafting was speeded up. These changes were under the direction of Mr. H. W. Jacobs and in line with those described by him in an extensive article on "High-Speed Steel in Railroad Shops," page 338 of the September, 1904, issue of this journal. This matter of railroad shop machine tool equipment is considered at length in the third number of a series of articles by Mr. Jacobs on "Organization and Economy in the Railroad Machine Shop" in the November issue of *The Engineering Magazine*. Mr. Jacob's series of articles began in the September issue of that magazine, and will be concluded in the January issue.

FIG. 9.—PART OF TOOL RACK IN TOPEKA STOREHOUSE CONTAINING LATHE, PLANER, AND BORING TOOLS FOR SHIPMENT.

[illegible] readily be removed by withdrawing the two rawhide pins and a shorter piece inserted to take its place. Various lengths of these take up pieces are kept in stock (Fig. 6), and it is a matter of [illegible] a few minutes to put in a shorter piece and properly [illegible]


BELT RECORD CARD

Step
Machine
Position

[illegible]STRUCTIONS [illegible] REMARKS

[illegible] is strikingly illustrated in this instance, and the following specifications for belting on the Santa Fe are of [illegible]

[illegible] quality leather, strictly [illegible] of the center of the hide and no [illegible] the weight. [illegible] will be rejected and must be replaced [illegible] Railroad Company. [illegible] the splice, and show elongation [illegible]

[illegible]

It is [illegible] the belt [illegible] placing it upon them.

[illegible] systematic way in which the [illegible] handled, thus showing the careful in[illegible] of details by the betterment de[illegible] general idea of the methods pursued [illegible] are reproduced from the "Rules [illegible] Repairmen" compiled by Mr. [illegible] Santa Fe: [illegible] to be noted in making a cement splice is to see that the pieces put together are of about the same grade, width and thickness, and that the splices line in the same direction in the same belt. Splices should be made of the length given in the table:

Width of Belt	Length of Splice
1 in.	[illegible]
2 in.	5 ins.
3 in.	6 ins.
4 ins.	6 ins.
[illegible]	7 ins.
[illegible]	8 ins.
7 ins.	8 ins.
8 ins.	[illegible]
9 ins. to 18 ins.	[illegible]
Over 18 ins.	[illegible]

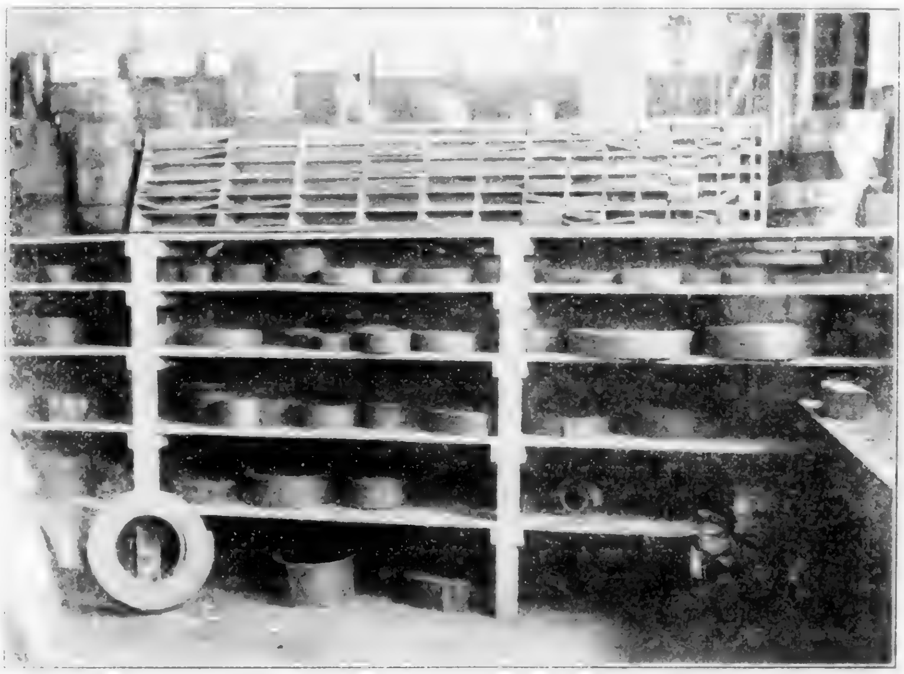
Splices should be worked down to a perfectly smooth, even surface, square with the edge of the belt both at the point and back. Care should be taken that the splice is no thicker than the rest of the belt. If the splice is thick the belt will not run even. Square both ends of the splice from the same edge of the belt. Work on a perfectly smooth, flat surface. After dressing the ends for the [illegible] them together on a board [illegible] than the splice. Place the edges from which the splices are squared in a perfectly straight line. Tack the belt to a board, just back of the splice. Open the splice and spread on [illegible] place another board on top of the splice and clamp tightly with hand clamps or in a press. (An old letter press makes an excellent belt press.) If a press is used, ten minutes is long enough to keep pressure on the belt, but if hand clamps are used they must be left on for three or four hours. In either case the belt should not be put under tension for at least five hours after gluing. Paper placed between the boards and the belt will prevent the belt from becoming glued to the boards.

Greasy belts should be cleaned in gasoline before attempting to cement them. Any grease in the belts or glue is liable to cause the splice to fail. No rivets, wire pegs, or any other fastenings aside from cement should be used in splicing belts. Ordinary furniture or patternmaker's glue is satisfactory for belting.

Width of Belting.—A pulley should be 25 per cent. wider than the belt running on it. This rule should be followed as closely as possible, and especially with cone pulleys.

Tension and Thickness of Belts.—Belts should have a tension when at rest of about 100 lbs. per sq. in. of width of good double belting. If not practical to measure the tension on the belt, make the fit length 1 in. per 10 ft. less than the tape-measured length over the pulleys. A steel tape should be used. Great care should be taken to prevent the running of too tight belts and consequent burning of bearings.

Double belts should not be run on pulleys less than 6 in. in diameter, and triple belts on pulleys less than 20 in. in diameter. Belts should sag onto the pulleys and not away from them. Very short drives (belts under 20 ft. long) should be avoided. Whenever possible, run up-and-down belts on a slant, so that the belt will sage onto the pulley.



[illegible] BELT ROOM SHOWING STOCK OF TAKE-UP PIECES AND BELTING.

For each horsepower to be transmitted allow 80 sq. ft. of double belt to pass over the pulleys per minute; allow 160 sq. ft. of single belt, or 1,000 lineal ft. of double [illegible] 2,000 [illegible] single belt.

Kind of Lace to Use.—For general service, the Jackson lace should be used, and new belts should have a 6-in. take-up piece put in them to permit the tightening of the belt by putting [illegible] piece, and thus avoiding the need of taking the entire belt down. Belts with Jackson lace should have a take-up piece in them at [illegible] times. Pieces should be kept in stock in sufficient numbers to avoid the necessity of making one in an [illegible] be 6, 5, 4, 3, 2, and 1 ins.

The Kerr lace may be used to hold very thick belts and small feed belts which the Jackson lace will not accommodate.

The rawhide lace [illegible]

FIG. 7.—HIGH SPEED STEEL LATHE TOOL [illegible] SYMBOL NUMBERS FOR ORDERING.

[illegible] woodworking machines [illegible] Jackson or Kerr lace, but it is generally best to make the belt endless [illegible] Jackson lace give satisfaction.

Endless Belts.—All machines furnished with any means of taking up the stretch should have endless belts. Large overhead drive belts (over 6 ins. wide) should be made endless as soon as the stretch is taken out. It is not advisable to make new endless belts at installation on account of the stretching. Woodworking machinery [illegible] better with endless than laced belts. Side and bottom head belts [illegible]

Cleaning and Oiling.—Belts which have become too greasy and dirty should be cleaned in gasoline, then scraped and wiped with waste. In dry, dusty places it is well to brush them occasionally with a broom or stiff brush.

No rosin or belt dope should be used except fish oil and tallow

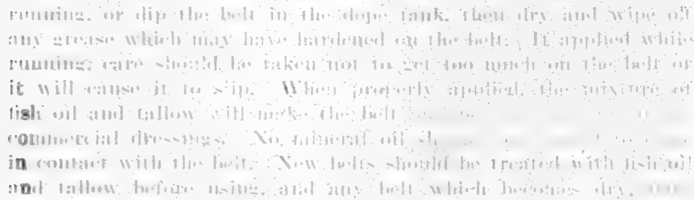


FIG. 8.—STANDARD [illegible] SYMBOL NUMBERS FOR ORDERING.

mixed in equal parts. Apply hot with a brush when the belt is running, or dip the belt in the dope tank, then dry and wipe off any grease which may have hardened on the belt. If applied while running, care should be taken not to get too much on the belt or it will cause it to slip. When properly applied, the mixture of fish oil and tallow will make the belt [illegible] commercial dressings. No mineral oil should [illegible] in contact with the belt. New belts should be treated with fish oil and tallow before using, and any belt which becomes dry, [illegible] and glossy in service should have an application of the dressing. This is especially true of belts in blacksmith shops. The oil will check to some extent the evil effects of the smoke, sulphur gases and dirt, and the life of the belt will thereby be lengthened.

Inspection of Belts.—Close attention should be given to the condition of the belting to prevent damage to it and delay to the machines. Such delays can be reduced to a minimum by making repairs as soon as weakness develops. Main drive and section belts should be watched very closely, since a failure of one of them may shut down a number of machines for a considerable length of time.

Operation of Belts.—The most essential thing to the successful operation of belts is that pulleys and shafting be properly lined and in good repair. It is bad practice to throw a pulley out of line to favor a bad belt. Belts should be run with the hair side to the face of the pulley. Run the belts so that the outside point of the splice trails. This will avoid opening of the splice by the action [illegible] on cones. [illegible] come in contact with the belts. If hard grease [illegible] is allowed to pile up in the corners of the cones, so as [illegible] belt will be very likely to climb, turn [illegible]

[illegible] throwing belts onto the pulleys, first [illegible] pulley (loose, if there is one) and [illegible] pulley. Avoid accidents by stopping the motor [illegible] run the belt on while starting slowly.

Care should be taken never to run a [illegible] [illegible] If necessary to cut a belt down, care should [illegible]

A belt should never be dampened in order to open the splice. An awl should be used, gradually scratching or ripping the splice apart.

It is good practice to remove the tension from the belts by [illegible] convenient, at quitting time. All cone and [illegible] should be run off of the pulleys at quitting [illegible]

Tools and Machinery.

The next step taken was [illegible] [illegible] machine tools. Each [illegible] examined, and in many instances it was found [illegible] to redesign and strengthen certain parts in order to properly adapt the tools for the use of high-speed steel and the improved methods which it was proposed [illegible] Pinions and gears were in many instances replaced with steel. Cone feed pulleys were increased in size to accommodate heavier feeds. Cone pulleys were redesigned to take [illegible]

FIG. 9.—PART OF TOOL [illegible] CONTAINING LATHE, PLANER AND BORING TOOLS [illegible]

belts and transmit more power. The [illegible] was speeded up. These changes were under the direction of Mr. H. W. Jacobs and in line with those described by him in an extensive article on "High-Speed Steel in Railroad Shops," page 338, of the September, 1904, issue of this journal. This matter of railroad shop machine tool equipment is considered at length in the third number of a series of articles by Mr. Jacobs on "Organization and Economy in the Railroad Machine Shop" in the November issue of *The Engineering Magazine*. Mr. Jacob's series of articles began in the September issue of that magazine, and will be concluded in the January issue.

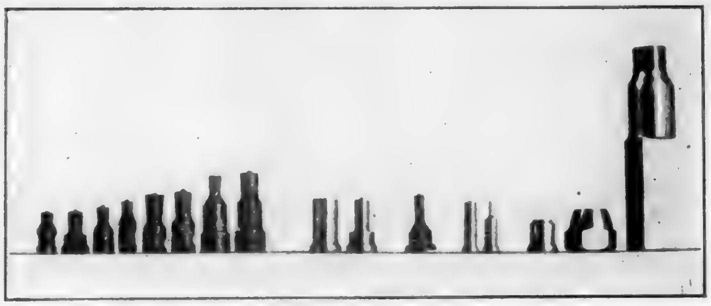


FIG. 12.—OLD AND NEW PUNCHES COMPARED.

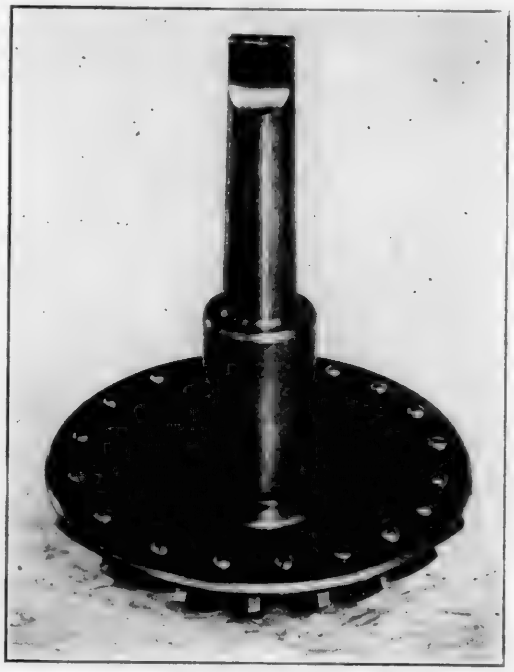


FIG. 13.—STANDARD BALL JOINT REAMER.

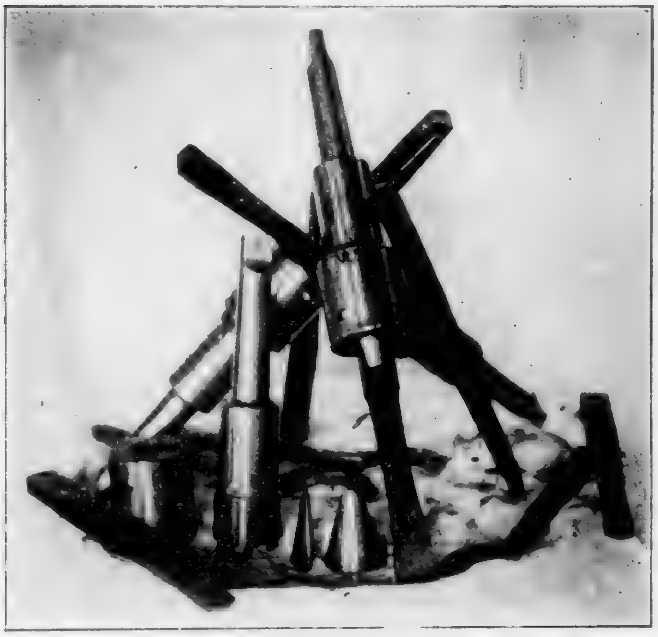


FIG. 14.—STANDARD CHUCK FOR HIGH SPEED FLAT DRILLS

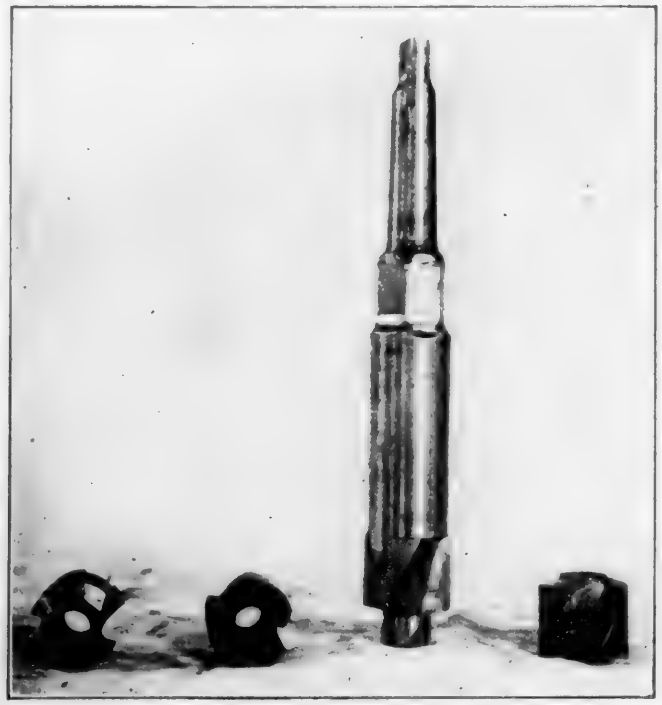


FIG. 15.—HIGH SPEED FLUE SHEET REAMER.

FIG. 17.—BOARD SHOWING TOOLS ORDERED, IN STOCK AND ON REQUISITION.

FIG. 16.—TOOL HOLDERS AND TOOLS COMPARED TO SOLID TOOLS.

At the same time standard shapes and standard material for cutting tools were selected by Mr. Jacobs to replace the large miscellaneous collection of cutting tools of all kinds, makes, shapes and qualities of material. At the present time practically all the cutting tools for the system are made at the Topeka shops. Each shop is furnished with a series of blue prints, similar to those shown in Figs. 7 and 8, showing the various tools, and from these necessary supplies are ordered by symbol number. Shaping and tempering the tools in accordance with the best practice and manufacturing them in large quantities at the Topeka shops has not only greatly increased their efficiency, but has also effected a very considerable saving.

It is, of course, impossible to go into this question in detail in this article, but a few typical examples of what has been accomplished will be considered. Fig. 9 shows part of a rack in the storehouse at Topeka containing the lathe, planer and boring tools and tool holders in stock and ready for shipment to outside points.

The punches and dies for the system have been standardized, as shown by the accompanying illustrations (Figs. 10, 11 and 12). Punches ⅝ in. and less in diameter fit a standard sleeve (Fig. 11), making it possible to use the same coupling as for the larger sizes and yet greatly reduce the cost of these smaller sizes, since they may be made from a much smaller stock than would be required if the sleeve was not used. Fig. 12 shows at the left a miscellaneous collection of old punches, then two of the larger standard punches, an old-type punch of the smaller size, compared to two of the new standard smaller size punches and sleeve and a standard coupling.

Flue rollers, flue expanders, reamers, flat drills, taps, rivet sets, flue beading tools, etc., have also been standardized. Ball joint reamers, Fig. 13, used for steam pipe joints, etc.,

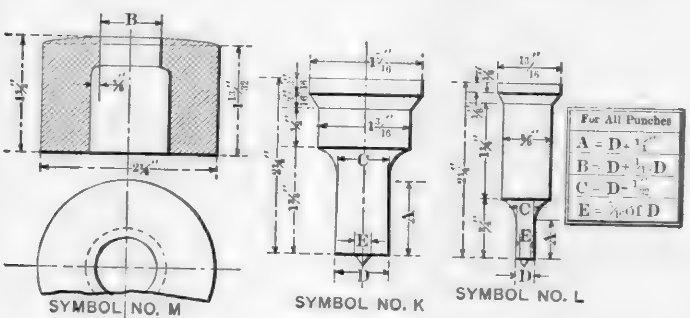


FIG. 10.—STANDARD PUNCHES AND DIES.

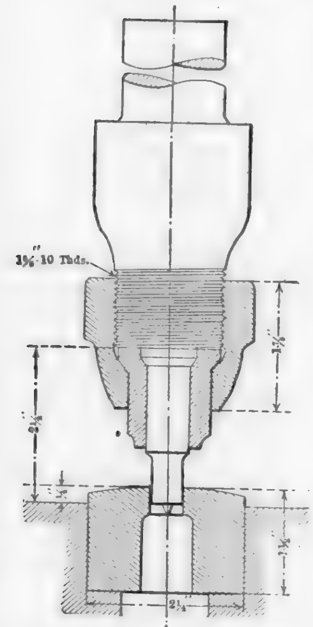


FIG. 11.—STANDARD REDUCING COUPLING AND PUNCH.

have been reduced to two standard sizes, thus doing away with a large number of miscellaneous reamers.

A standard chuck for flat high-speed drills is shown in detail in Fig. 14, and these, as well as the drills to fit them, are manufactured for the system in large quantities at the Topeka shops.

The flue sheet reamer shown in Fig. 15 has a high-speed cutter on a soft steel arbor. At the Topeka shops these reamers are reaming holes at a rate exceeding one per minute. The cutter may be easily and cheaply replaced if broken or if it requires regrinding, and standard sizes may be maintained at a comparatively small cost.

High-speed tool steel is very expensive, and it was found that by designing and using proper tool holders the amount of this steel which would be required could be reduced to a minimum. One of the illustrations (Fig. 16) shows several of these tool holders with the small tools as compared to the old type solid tools.

The board shown in Fig. 17 is kept in the office of the tool department at Topeka, and shows just how many of each type of tool is on hand in the storehouse; how many are being made on shop orders, and how many have been ordered on requisition from outside points. The lower part of the board is adapted to show just what special tools and jigs have been ordered and where they are being made in the shop. This arrangement enables the man in charge to keep a careful check on the manufacture and shipment of tools, and see that requisitions are filled as promptly as possible. A record is kept of the tools ordered and used at the various shops, and it is thus possible to correct any abuse and prevent an excessive number from being carried at the different points.

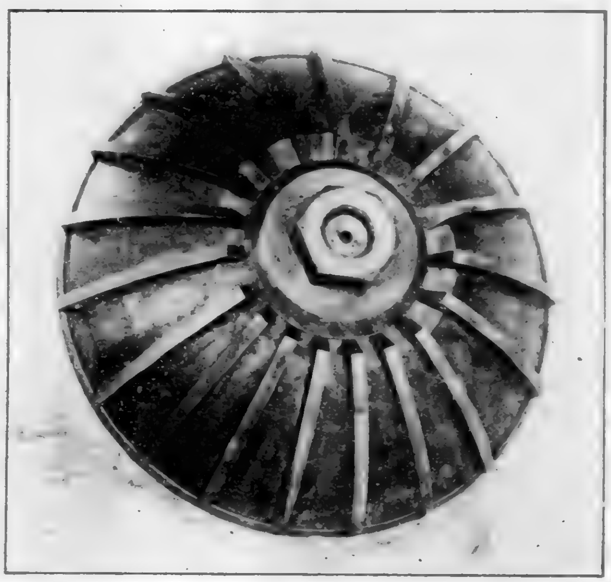


FIG. 13a.—ANOTHER VIEW OF STD. BALL JOINT REAMER.

Special chucks and devices for facilitating the chucking of work and holding it more firmly, in order to make it possible to take more or heavier cuts, were devised, and these have been instrumental in greatly reducing the cost of manufacture. The method of milling piston valve bushings, shown in Fig. 18, is a very good illustration of this. Formerly only one hole was milled at a time, and the bushing was adjusted by hand for each set of holes. By the new method four holes are milled at one time, and the mandrel which supports the bushing is revolved by a worm and gear as shown.

Another good illustration is that of milling eccentric straps, Fig. 19. The eccentric straps are first clamped to the cast iron jig and the long bolts are then adjusted, as shown, preventing the straps from shifting, and making it possible to take as heavy cuts as may be necessary.

These are typical instances of improvements made in the machine shop proper. A number of interesting tools and devices were also noticed in the erecting shop, which, while possibly not all new, play an important part in increasing the output and reducing its cost. Space permits the mention of only two or three typical examples.

The pneumatic air drum hoist, Fig 20, makes it possible to raise an air drum for less than one-tenth of the cost under former conditions.

A pneumatic hammer for removing frame or other bolts is shown in Fig. 21. This is less than 12 in. high, and may be used in places where it is impossible to use a sledge. After being placed in position the lower lever is turned, forcing the plunger against the bolt. Then by quickly operating the upper handle a series of heavy blows drives the bolt out. This was devised and patented by Mr. A. Parfitt, boiler shop foreman.

Two other tools devised by Mr. Parfitt are shown in Figs. 22 and 23. The first is a portable hydro-pneumatic bushing extractor used largely in connection with piston valve bushings, and capable of exerting a pressure of 1,500 lbs. per sq in. The other is a portable hydro-pneumatic punch for use in the boiler shop.

A very considerable saving has been made due to improving the efficiency and reducing the cost of maintenance of pneumatic tools. Every Saturday all of these tools are turned in and carefully examined, repaired and oiled by a man in charge of this work. As in the matter of belts, the aim is to prevent failures and keep the tools in first-class condition all the time.

Although the prime object was to improve the efficiency of the tools and machinery, it has resulted in a marked improvement in economy as indicated by the diagrams, Figs. 24 and 25; Fig. 24 shows what has been accomplished in reducing the tool and machinery account on the Santa Fe System. This, of course, includes all the expenses in connection with the maintenance of the machinery and tools, including the

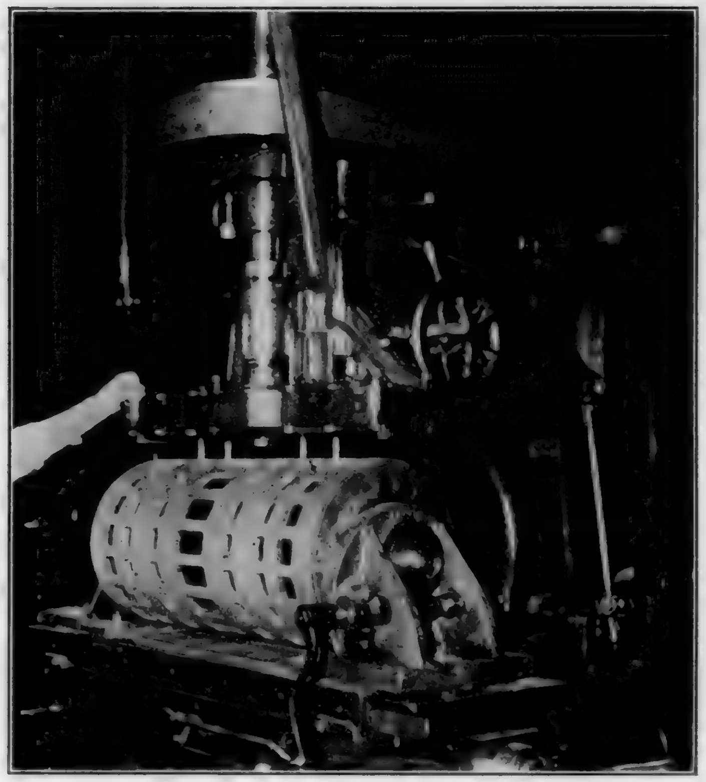


FIG. 18.—IMPROVED METHOD OF MILLING PISTON VALVE BUSHINGS.

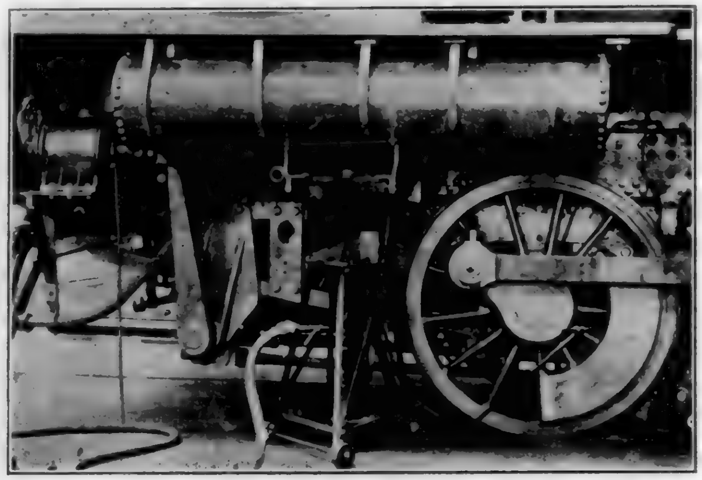


FIG. 20.—PNEUMATIC AIR DRUM HOIST.

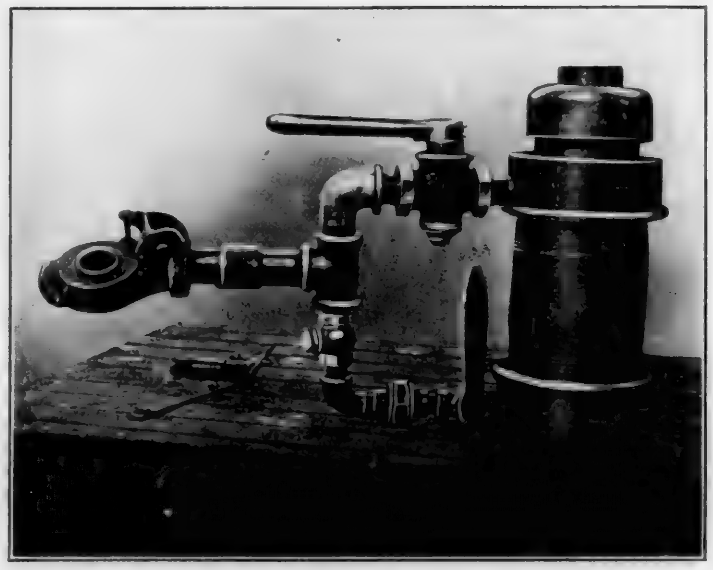


FIG. 21.—PNEUMATIC HAMMER FOR REMOVING FRAME BOLTS.

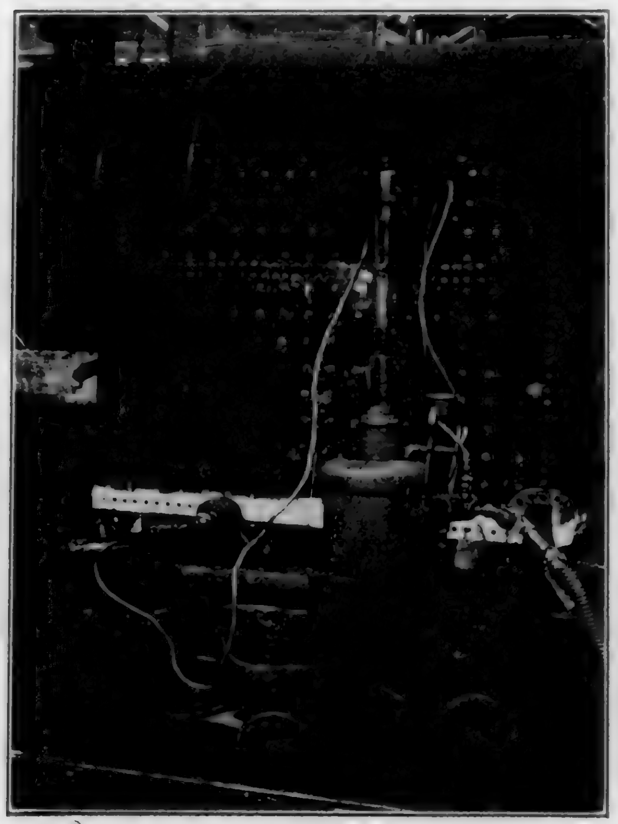


FIG. 23.—PORTABLE HYDRO-PNEUMATIC PUNCH.

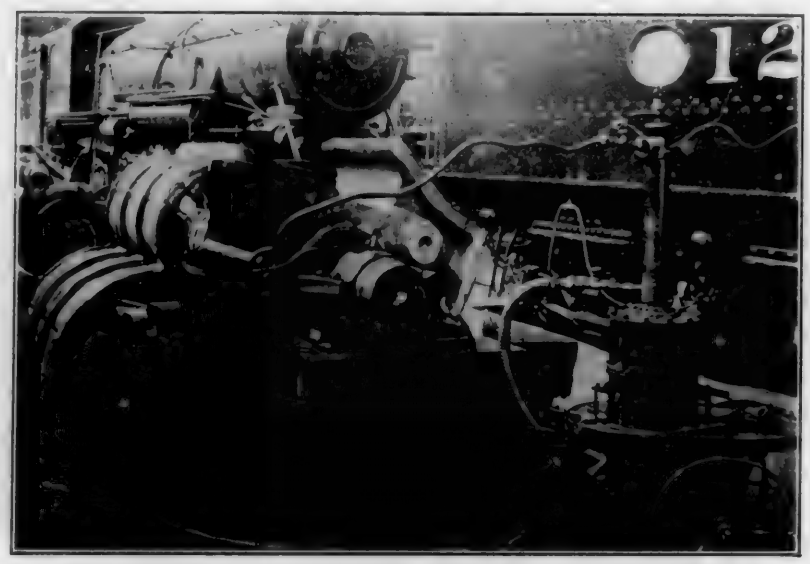


FIG. 22.—HYDRO-PNEUMATIC PISTON VALVE BUSHING EXTRACTOR.

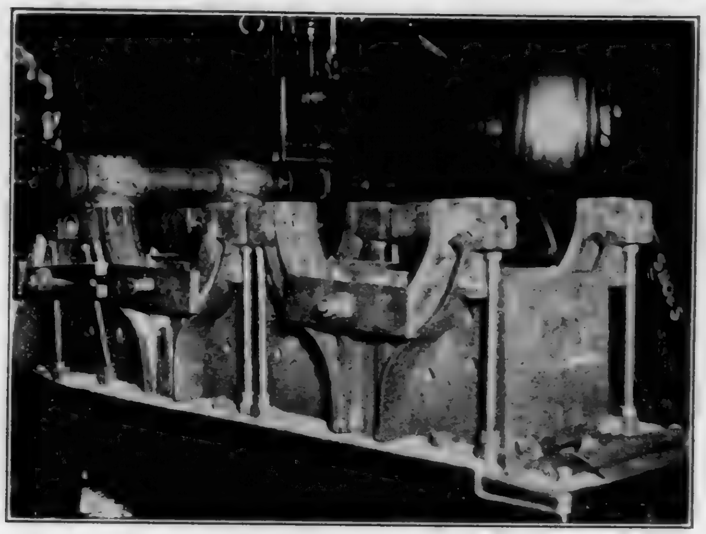


FIG. 19.—MILLING ECCENTRIC STRAPS.

belting, shafting, etc. The total cost is on a different scale from the labor and material cost in order that the diagram may not be too large. The lines marked "allotment for total cost," "allotment for material cost" and "allotment for labor cost" are the ideal points which it is desired to attain. These ideal points are not laid down arbitrarily, but are based on results which it is known are possible of attainment. Fig. 25 is for the Topeka shops. It was at this point that the work was started and has received the greatest amount of attention.

Diagrams similar to these are drawn up for each division on the system, and it is thus possible to follow this matter very closely. Each master mechanic has a fair and definite allotment, within which he is expected to keep. Every month each shop must send in on a form similar to that shown in Fig. 26 the cost for the maintenance of tools and machinery during the month. Separating and subdividing the various items in the account makes it possible to locate and correct weak spots or abuses.

In September, 1904, the expense for the system was $45-125.10 per month. In April, 1906, it had fallen to $24,921.25 per month, or a little less than the "allotment for total cost" of $25,000 per month.

This result was accomplished largely by special efforts at Topeka, Albuquerque and San Bernardino, the total expense for tools and machinery at these three points amounting to 65 per cent. of the total for the system in January, 1905. This reduction was made in spite of the fact that the efficiency was very greatly increased by introducing better tools and by strengthening and considerably increasing the capacity of the machinery and equipment.

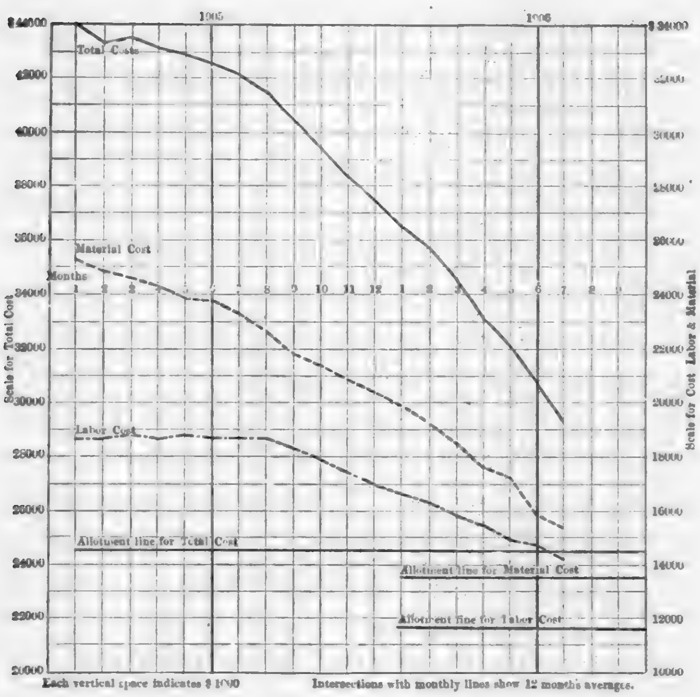


FIG. 24.—GRAPHICAL RECORD OF COST OF MAINTENANCE OF TOOLS AND MACHINERY ON THE SANTA FE SYSTEM.

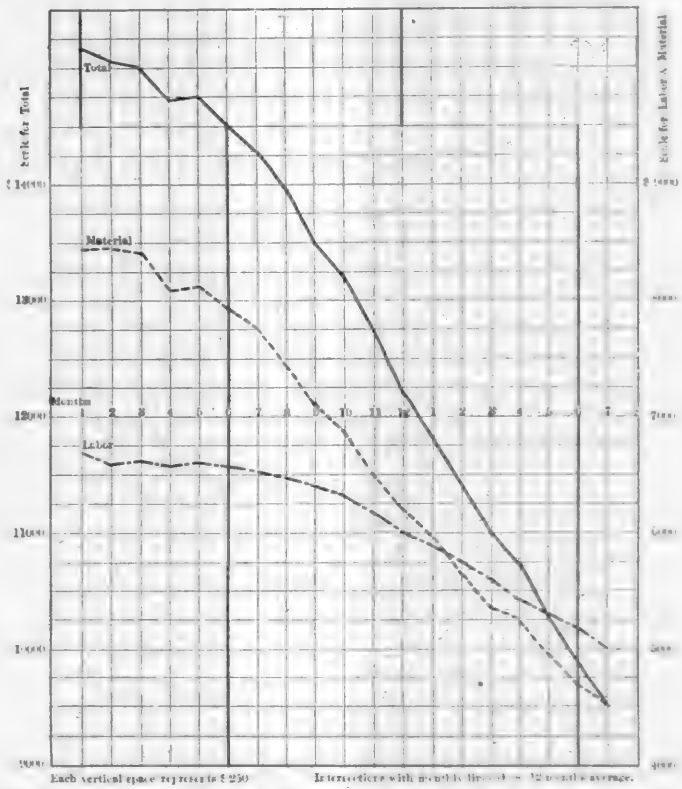
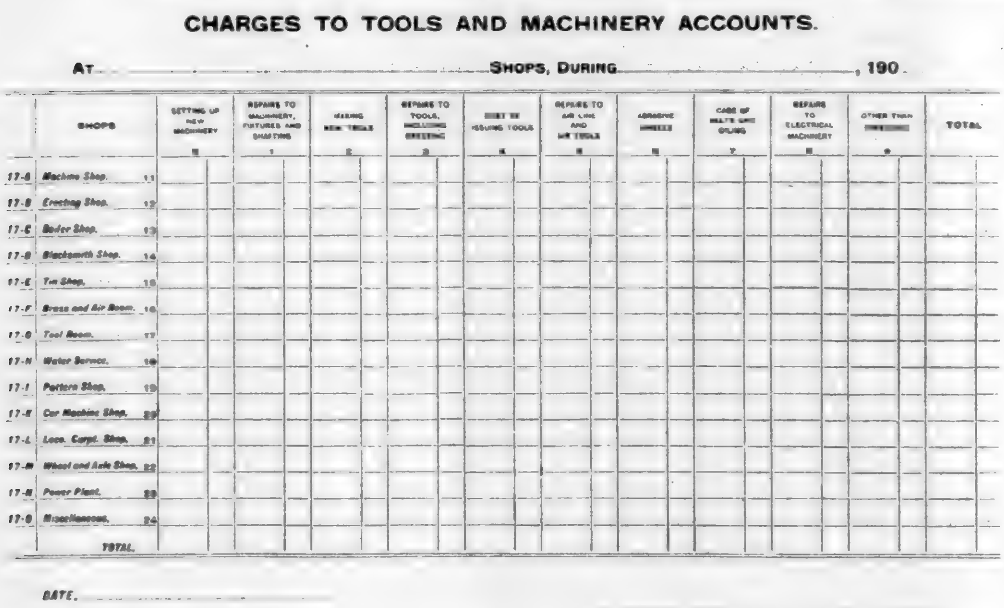


FIG. 25.—GRAPHICAL RECORD OF COST OF MAINTENANCE OF TOOLS AND MACHINERY AT THE TOPEKA SHOPS.



CHARGES TO TOOLS AND MACHINERY ACCOUNTS.

AT .... SHOPS, DURING .... , 190 .

	SHOPS	SETTING UP NEW MACHINERY	REPAIRS TO MACHINERY, FIXTURES AND SHAFTING	MAKING NEW TOOLS	REPAIRS TO TOOLS, [illegible]	[illegible] ISSUING TOOLS	REPAIRS TO AIR LINE AND AIR TOOLS	ABRASIVE [illegible]	CARE OF BELTS AND OILING	REPAIRS TO ELECTRICAL MACHINERY	OTHER THAN [illegible]	TOTAL
		0	1	2	3	4	5	6	7	8	9	
17-A	Machine Shop. 11											
17-B	Erecting Shop. 12											
17-C	Boiler Shop. 13											
17-D	Blacksmith Shop. 14											
17-E	Tin Shop. 15											
17-F	Brass and Air Room. 16											
17-G	Tool Room. 17											
17-H	Water Service. 18											
17-I	Pattern Shop. 19											
17-K	Car Machine Shop. 20											
17-L	Loco. Carpt. Shop. 21											
17-M	Wheel and Axle Shop. 22											
17-N	Power Plant. 23											
17-O	Miscellaneous. 24											
	TOTAL.											

DATE ....

.... FOREMAN

FIG. 26.—FORM USED IN CONNECTION WITH TOOL AND MACHINERY ACCOUNTS.

Two other tools devised by Mr. Parfitt are shown in Figs. 22 and 23. The first is a portable hydro-pneumatic bushing extractor used largely in connection with piston valve bushings, and capable of exerting a pressure of 1,500 lbs. per sq in. The other is a portable hydro-pneumatic punch for use in the boiler shop.

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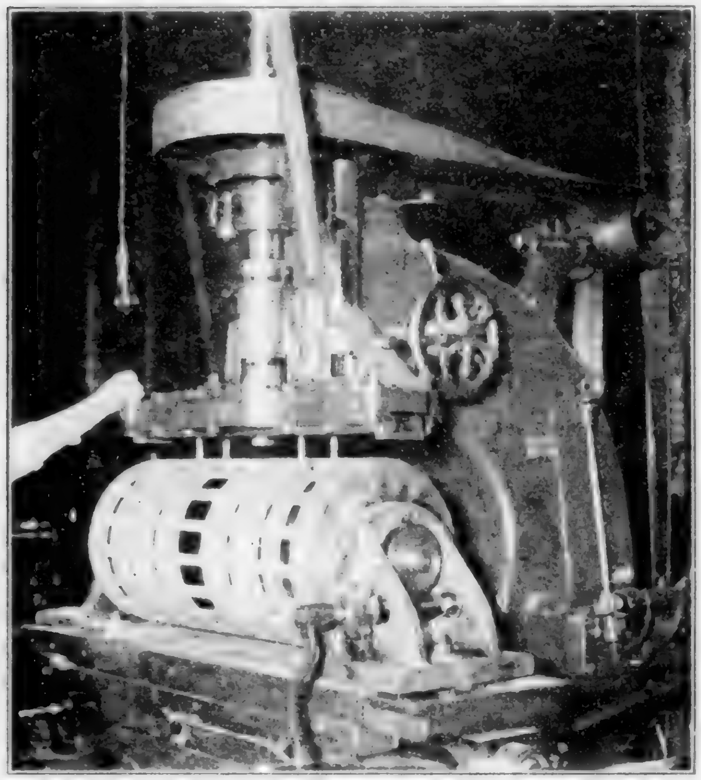


FIG. 18.—[illegible] PISTON VALVE BUSHINGS.

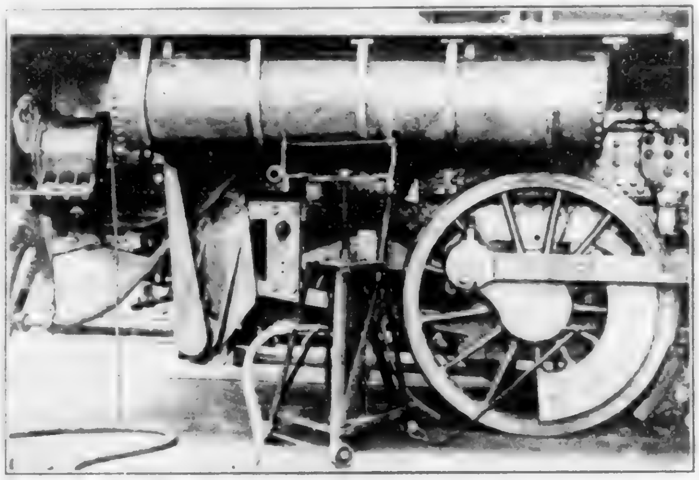


FIG. 20.—PNEUMATIC AIR DRUM HOIST

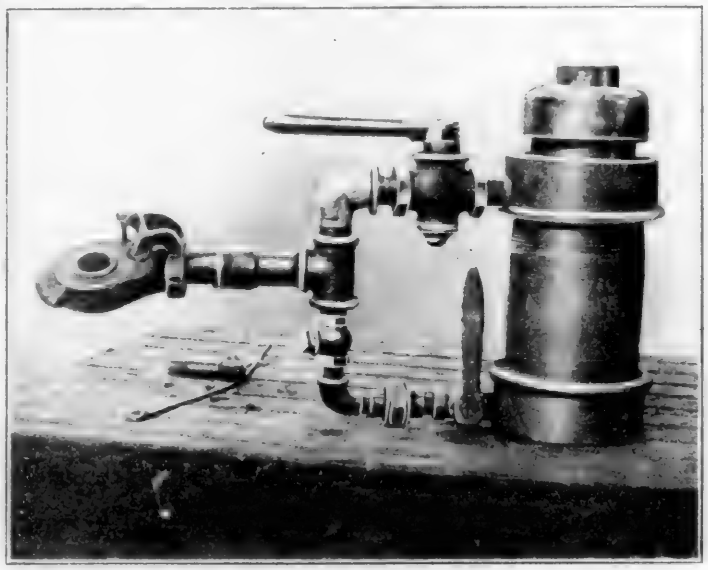


FIG. 21.—PNEUMATIC HAMMER FOR REMOVING FRAME BOLTS.

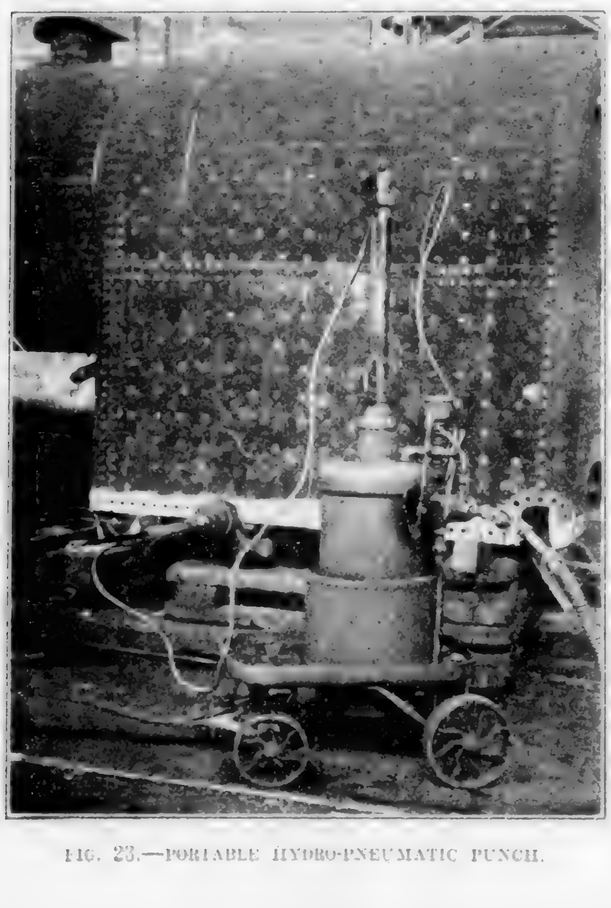


FIG. 23.—PORTABLE HYDRO-PNEUMATIC PUNCH.

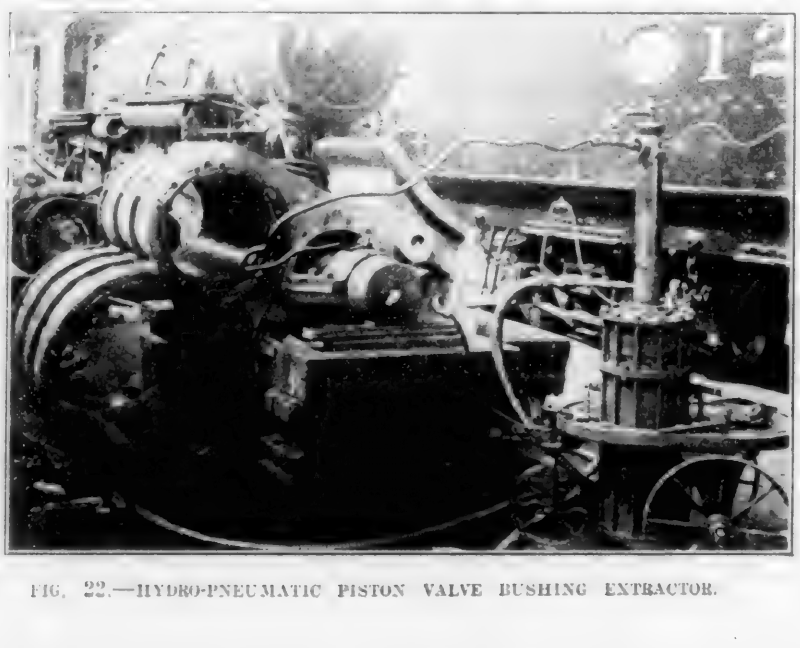


FIG. 22.—HYDRO-PNEUMATIC PISTON VALVE BUSHING EXTRACTOR.

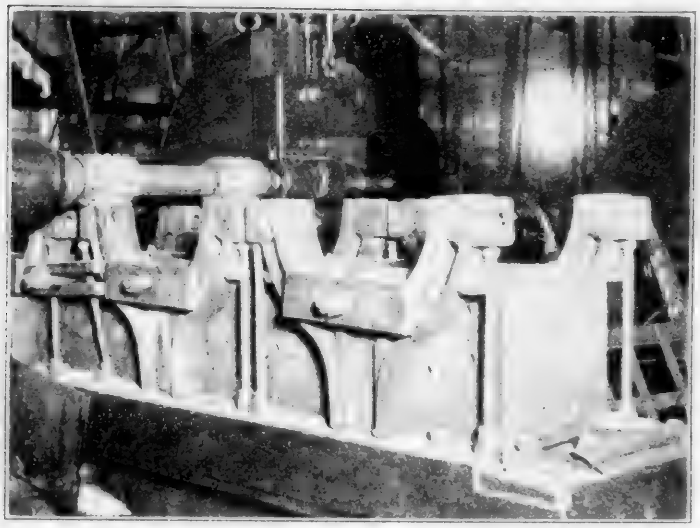


FIG. 19.—MILLING ECCENTRIC STRAPS.

belting, shafting, etc. The total cost is on a different scale from the labor and material cost in order that the diagram may not be too large. The lines marked "allotment for total cost," "allotment for material cost" and "allotment for labor cost" are the ideal points which it is desired to attain. These ideal points are not laid down arbitrarily, but are based on results which it is known are possible of attainment. Fig. 25 is for the Topeka shops. It was at this point that the work was started and has received the greatest amount of attention.

Diagrams similar to these are drawn up for each division on the system, and it is thus possible to follow this matter very closely. Each master mechanic has a fair and definite allotment, within which he is expected to keep. Every month each shop must send in on a form similar to that shown in Fig. 26 the cost for the maintenance of tools and machinery during the month. Separating and subdividing the various items in the account makes it possible to locate and correct

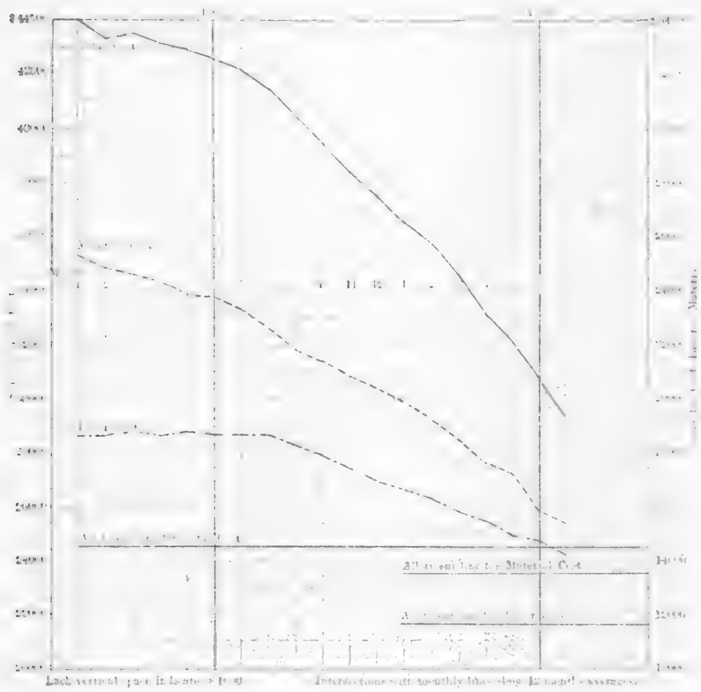


FIG. 24.—GRAPHICAL RECORD OF COST OF MAINTENANCE OF TOOLS AND MACHINERY ON THE SANTA FE SYSTEM.

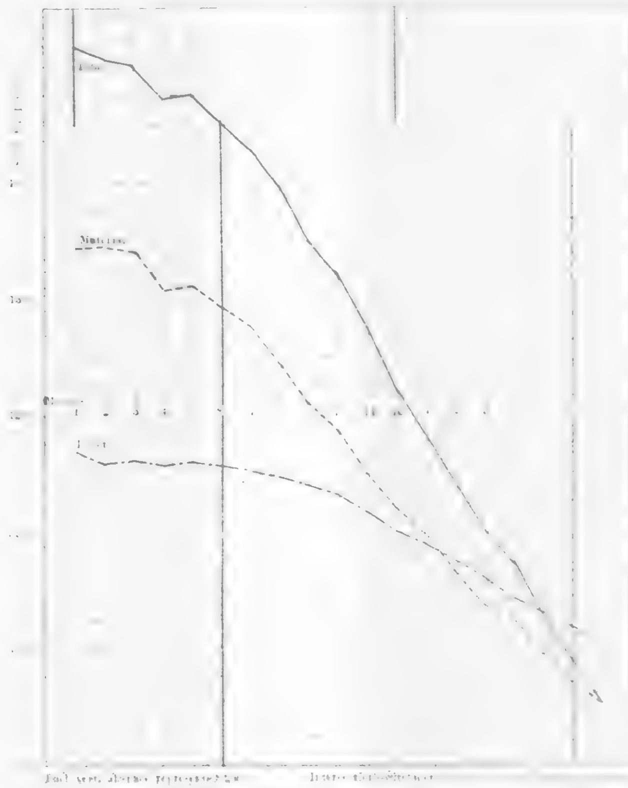
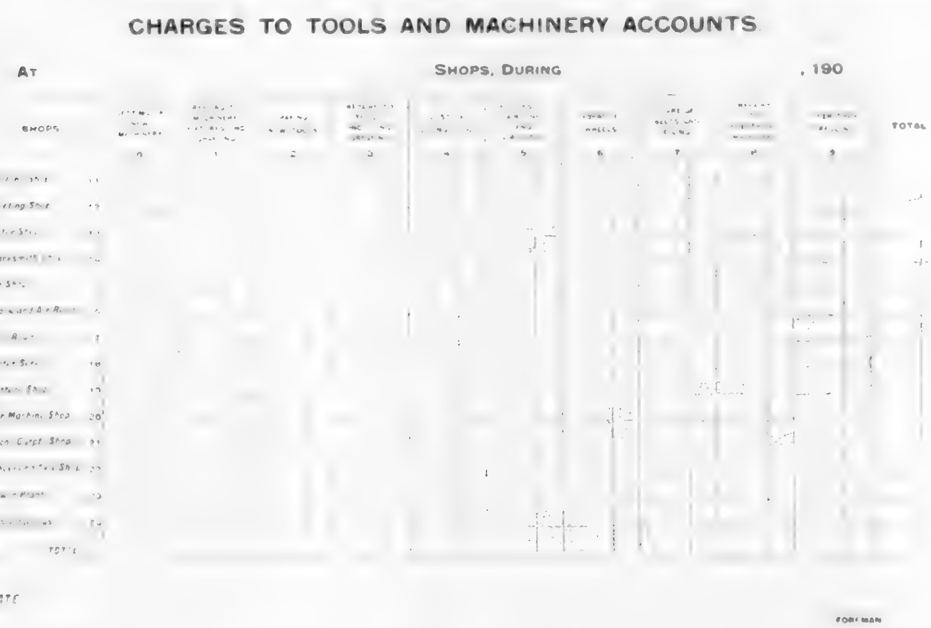


FIG. 25.—GRAPHICAL RECORD OF COST OF MAINTENANCE OF TOOLS AND MACHINERY AT THE TOPEKA SHOPS.



CHARGES TO TOOLS AND MACHINERY ACCOUNTS

AT SHOPS, DURING , 190

SHOPS		0	1	2	3	4	5	6	7	8	9	TOTAL
17 A Machine Shop												
17 B Erecting Shop												
17 C Boiler Shop												
17 D Blacksmith Shop												
17 E Tin Shop												
17 F Brass and Air Room												
17 G Tool Room												
17 H Motor Shop	18											
17 I Pattern Shop	19											
17 K Car Machine Shop	20											
17 L Loco. Carpt. Shop	21											
17 M Wheel [illegible] Shop	22											
17 N Power Plant	23											
17 O Miscellaneous	24											
TOTAL												

DATE

FOREMAN

FIG. 26.—FORM USED IN CONNECTION WITH TOOL AND MACHINERY ACCOUNTS.

weak spots or abuses.

In September, 1904, the expense for the system was $45-125.10 per month. In April, 1906, it had fallen to $24,921.25 per month, or a little less than the "allotment for total cost" of $25,000 per month.

This result was accomplished largely by special efforts at Topeka, Albuquerque and San Bernardino, the total expense for tools and machinery at these three points amounting to 65 per cent. of the total for the system in January, 1905. This reduction was made in spite of the fact that the efficiency was very greatly increased by introducing better tools and by strengthening and considerably increasing the capacity of the machinery and equipment.

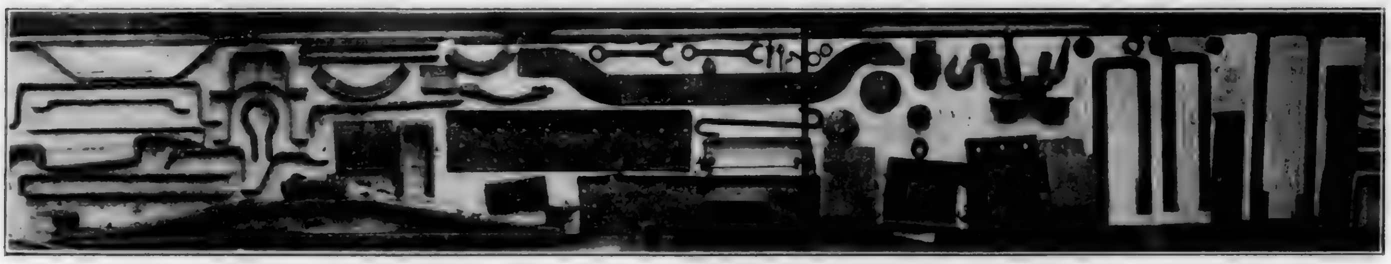
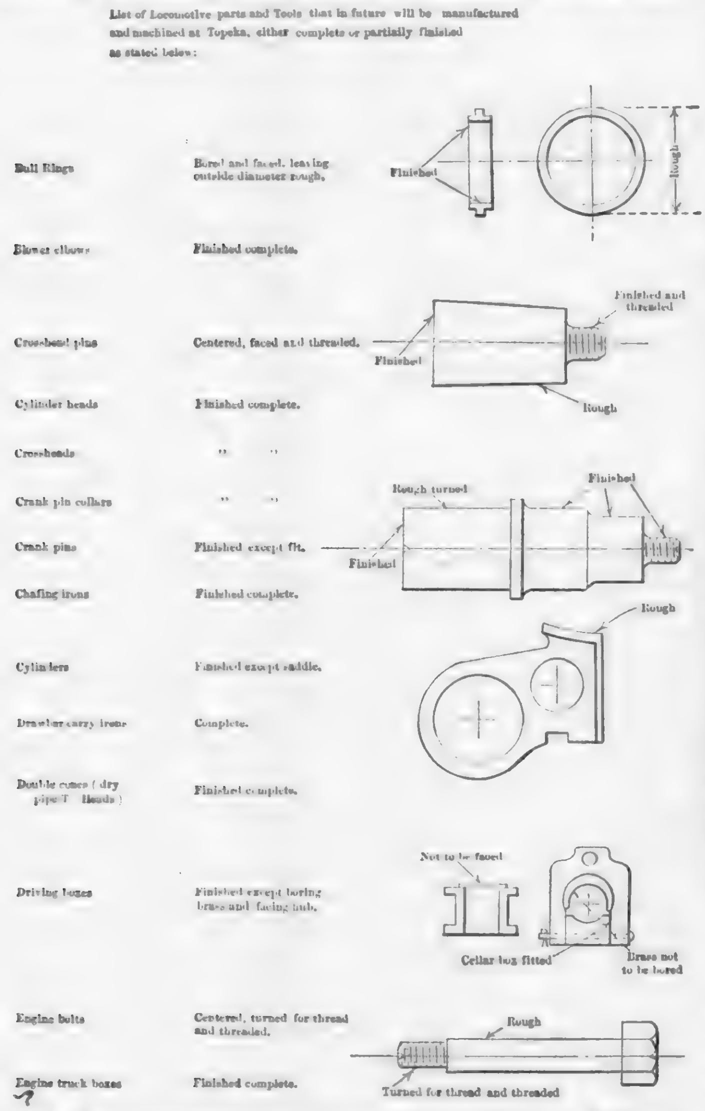


FIG. 30.—EXAMPLES OF WORK DONE ON FORGING MACHINES AND BULLDOZERS AT TOPEKA.

Centralization of Manufactured Material and Extension of Standards.

At the same time that the efficiency of the tools and machinery was being improved a movement was made to standardize, as far as possible, the various locomotive parts and do all the manufacturing for the system at Topeka. At the present time all manufactured and machined material is furnished by the Topeka shops. In many instances it is, of course, impossible to finish a piece entirely, but as much machine work as possible is done on it in order to reduce to a minimum the work to be done at the outside shops. Fig. 27 is the first sheet of a circular giving a list of locomotive parts manu-



List of Locomotive parts and Tools that in future will be manufactured and machined at Topeka, either complete or partially finished as stated below:

Bull Rings	Bored and faced, leaving outside diameter rough.
Blower elbows	Finished complete.
Cross-head pins	Centered, faced and threaded.
Cylinder heads	Finished complete.
Crossheads	" "
Crank pin collars	" "
Crank pins	Finished except fit.
Chafing irons	Finished complete.
Cylinders	Finished except saddle.
Drawbar carry irons	Complete.
Double cones (dry pipe T heads)	Finished complete.
Driving boxes	Finished except boring brass and facing hub.
Engine bolts	Centered, turned for thread and threaded.
Engine truck boxes	Finished complete.

FIG. 27.—PARTIAL LIST OF PARTS MANUFACTURED AT TOPEKA.

factured at Topeka, and will give an idea of the extent to which this work is carried.

All turned bolts are to be made at Topeka. These bolts, of various lengths, are turned to standard sizes and placed in stock. Standard reamers are to be furnished each shop, and with each reamer are standard collars, so that the same reamer will ream holes to fit any one of several standard bolts, depending on the collar that is placed upon it. The reamers and collars are frequently checked with standards, and when worn are returned to Topeka for repairs.

Standard knuckle pin hole reamers with standard gauges, for the different classes of engines, are to be furnished to each shop and the large roundhouses. The reamers in each set vary from the standard size to 1/8 in. above by thirty-seconds. When a pin needs replacing the hole is reamed to the nearest size and a standard knuckle pin of a corresponding size, completely finished, is taken from stock.

Manufacturing all material at one point has many advantages; not only are the parts turned out much cheaper, better and more certain to be standard, but it is possible to use to advantage many special machines and devices which if placed in a smaller shop would lie idle the greater part of the time, thus making a very heavy surcharge on any of the work they might do. The work can, of course, be done with fewer machines at a central point than if it was being done at several points on the system.

The finished material storehouse platform at Topeka is shown in Fig. 28. With the store department in close co-operation with the mechanical department it is possible to keep an ample supply of finished material at the various repair plants, and by so doing it is, of course, possible to pass the engines through the shop for repairs and get them back in service in a minimum amount of time. This policy has been carried to such an extent at Topeka that even fireboxes for certain classes and cylinders are carried in stock ready to be placed on an engine as soon as it comes into the shop.

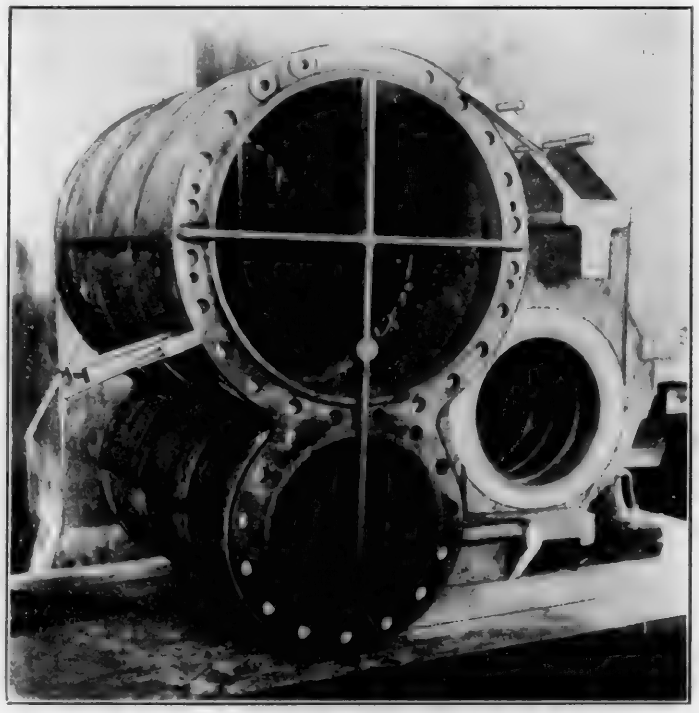


FIG. 29.—TEMPLATE FOR DRILLING COMPOUND CYLINDER.

A considerable improvement was effected by checking over the patterns and reducing the amount of material allowed for finish where it was excessive. In some instances it was found advisable to change the grade or kind of material to facilitate machining or to give better results in service.

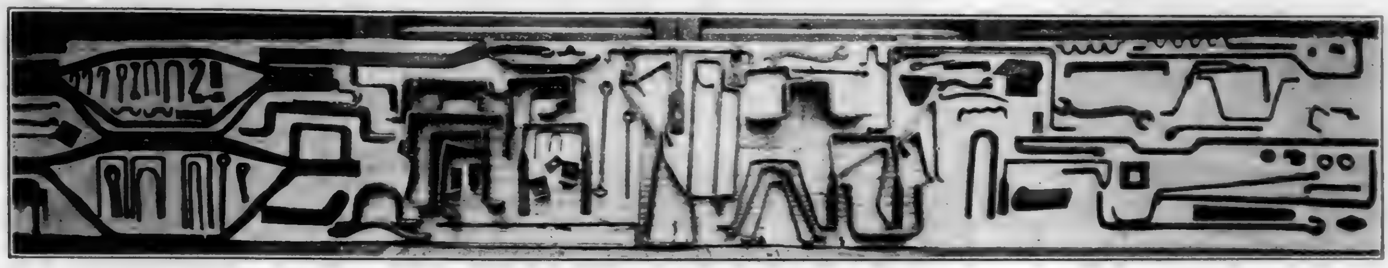


FIG. 30.—EXAMPLES OF WORK DONE ON FORGING MACHINES AND BULLDOZERS AT TOPEKA.

One noticeable feature at the Topeka shops is the large number of templets and jigs used. A templet for drilling holes in a compound cylinder for cylinder head studs is shown in Fig. 29. The equipment of templets and jigs for work of this kind is so complete that it is possible to drill all the holes in a cylinder casting without laying out a single one. In a small shop where parts are turned out at long intervals a complete equipment of such templets and jigs would, of course, be out of the question, but by concentrating work of this kind at one point they can be used to very great advantage.

FIG. 31.—SOME OF THE DIES AND FORMERS USED WITH THE FORGING MACHINES AND BULLDOZERS AT TOPEKA.

In no department is the manufacturing activity more evident than in the blacksmith shop. One of the photographs (Fig. 30) shows a number of parts made by dies and formers used in connection with the bulldozers and forging machines. There are about 200 sets of these dies and formers, part of which are shown in Fig. 31.

A very interesting and simple tool in this shop is one for making brakeshoe keys, devised and patented by Mr. George Fraser, the foreman. Part of the device (Fig. 32) is used in connection with a bulldozer, and forges two keys at one time from ¾-in. round scrap iron. The keys are then cut apart and sheared to shape by a special attachment used on an ordinary shear, as shown in Fig. 33. These brake shoe keys can be turned out by these tools at the rate of two or three thousand per day at an insignificant cost compared to the methods formerly used.

Individual Effort Method or Bonus System.

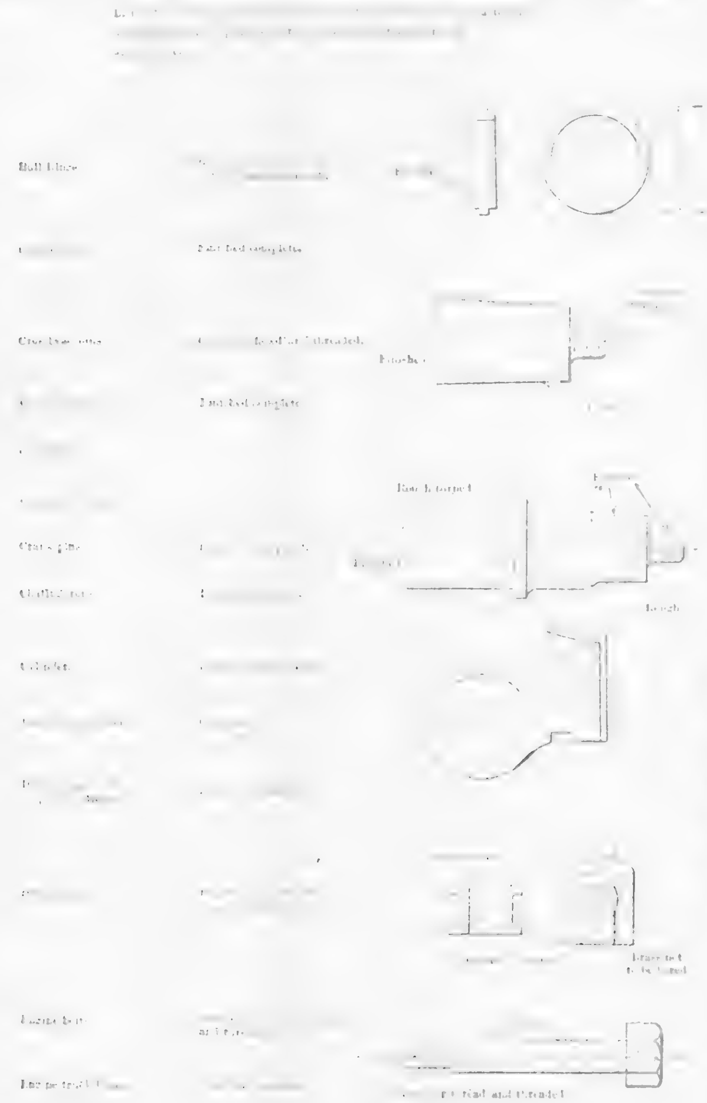
A general description of this system and its advantages is presented on page 61 of our February, 1906, issue. This article, entitled "Shop Betterment and the Individual Effort

FIG. 28.—FINISHED MATERIAL PLATFORM, TOPEKA STOREHOUSE.

FIG. 30.—EXAMPLES OF WORK DONE ON FORGING MACHINES AND BULLDOZERS AT TOPEKA.

Centralization of Manufactured Material and Extension of Standards.

At the same time that the efficiency of the tools and machinery was being improved a movement was made to standardize, as far as possible, the various locomotive parts and do all the manufacturing for the system at Topeka. At the present time all manufactured and machined material is furnished by the Topeka shops. In many instances it is, of course, impossible to finish a piece entirely, but as much machine work as possible is done on it in order to reduce to a minimum the work to be done at the outside shops. Fig. 27 is the first sheet of a circular giving a list of locomotive parts manu-



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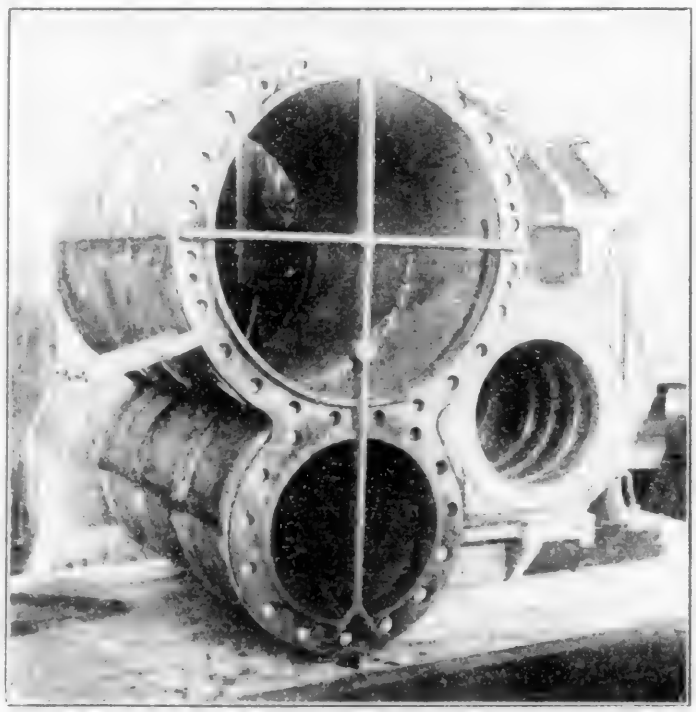

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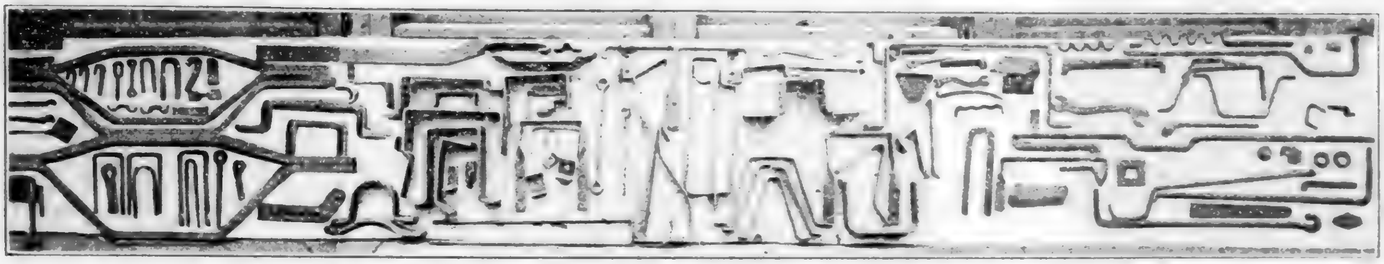

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FIG. 28.—FINISHED MATERIAL PLATFORM, TOPEKA STOREHOUSE.

Method of Profit Sharing," was prepared by Mr. Harrington Emerson and by direction of Mr. Lovell, superintendent of motive power was distributed among the motive power employes of the Santa Fe System. An understanding of this system and what may be accomplished by its use may probably best be conveyed by presenting an abstract of this treatise, although it is suggested that our readers will find the article itself much more comprehensive and complete.

The employer, of course, wishes to reduce the cost of output to a minimum in order to meet competition. The employe, on the other hand, wishes as high wages as he can get. A system by which the employer could pay higher wages than the average and at the same time cheapen the cost of output would be an ideal one. That this may be accomplished is indicated by a series of examples presented by Mr. Emerson. The first one is a cost statement of a large machine shop in an Eastern State, and is as follows:

FIG. 32.—BRAKE SHOE KEY FORGING DEVICE ON BULLDOZER.

COSTS OF OPERATION FROM JANUARY 1 TO AUGUST 31, 1905.

Cost of materials	$172,916.40
Wages paid to direct labor	49,174.98
General expenses	90,698.54
Total	$312,789.92

Output 500 engines, costing each—		Per Cent.
For material	$345.83	55.3
For direct labor	98.23	15.7
For general expenses	181.50	29
Total	$625.56	100

Day wages are less than one-sixth of the entire expense; general expenses more than twice as much as labor; and material more than one-half the total expense. In the general expenses only the cost to the factory door is included.

A careful study of the cost of materials, and this is the largest item in the above statement, will undoubtedly show that a considerable saving may be made by such methods as described in the previous section of this article and by securing the co-operation of the men. The general expenses include the wages of all employes not directly chargeable to the different engines and the cost and maintenance of the belts, machine tools, the furnishing of power, etc.

In attempting to decrease factory costs the method is usually to make a reduction in the wages paid to direct labor, although as seen from the above figures this is the smallest item of the three. Suppose the wages are reduced 10 per cent., the best men will leave and those who stay are discontented, while the new employes are slow and unskilled. Less work will be done and more material wasted, and it is safe to assume that for the same number of men and the same amount of material 10 per cent. less engines will be turned out. There will, of course, be no opportunity to reduce the general expenses, and as a matter of fact more foremen will be required to teach the new men. The account will therefore stand:

Materials	$172,916.40
Ten per cent. less wages paid to direct labor	44,257.48
General expenses	90,698.54
Total	$307,872.42
An apparent saving of	4,917.50
Total	$312,789.92

But if we consider output, another story is told:

Output 450 engines, costing each—		Per Cent.
For materials	$384.26	56.2
For direct labor	98.34	14.4
For general expenses	201.55	29.4
Total	$684.15	100

Put the two results side by side:

Cost Before Wages Were Reduced.	Per Cent. of Direct Labor.	Cost After Wages Were Reduced,	Per Cent of Direct Labor.
$625.57	15.7	$684.15	14.4

Both the employer and employes are losers.

If, on the other hand, the matter of materials is first considered, it will be found that by following such methods as described in the preceding section of this article it will be

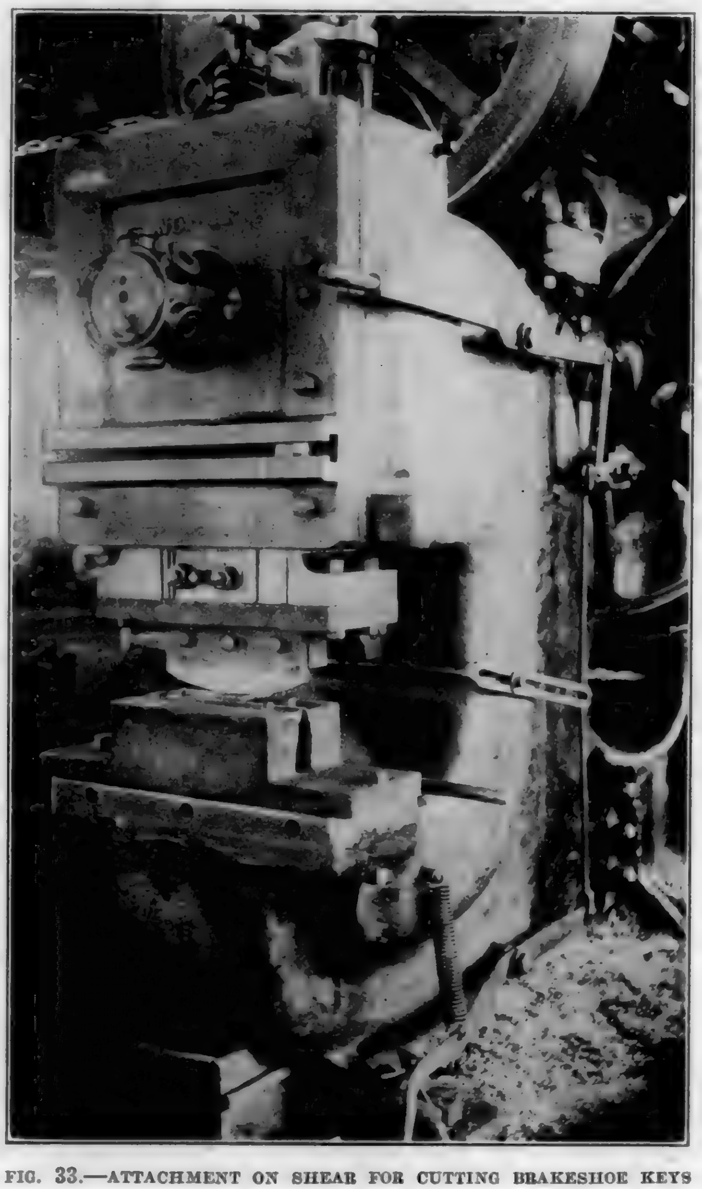

FIG. 33.—ATTACHMENT ON SHEAR FOR CUTTING BRAKESHOE KEYS TO SHAPE.

possible to make a very considerable saving in this item, and as the amount is so much greater than that paid for direct labor a small percentage would be equal to quite a large percentage of the direct labor charge.

Within certain limits the greater proportion of the general expense will remain about the same regardless of the output, and it is therefore, of course, advisable to increase the output to a maximum, making the charges against each engine due to this item a minimum. By improving the efficiency of the tools and machinery the output can readily be increased without increasing the expense as indicated by the results accomplished at Topeka. Assuming that the workman will co-operate to cut out unnecessary losses and wastes, if he is given an incentive, that the amount of increase of his pay depends upon his individual efforts, and that the average increase of pay amounts to 20 per cent., that the output is increased 20 per cent., but that the cost of material is increased only 10 per cent., and general expenses remain the same, the account would be as follows:

Materials	$190,208.04
Direct labor	49,174.98
Average increase, 20 per cent.	9,835.00
General expenses	90,698.54
Total	$339,916.56

Output of 600 engines, costing each—		Per Cent.
For material	$317.01	56
For direct labor	98.35	17.4
For general expenses	151.16	26.6
Total	$566.52	100

The employer pays his men an average of 20 per cent. more, and by all sorts of shop betterments, which cost a great deal to install and maintain, he enables them to obtain an average of 20 per cent. more output from the machines in the same time and without any more exertion to themselves; yet owing solely to the cutting out of useless wastes, the output costs 9 per cent. less. This 9 per cent. is the employers' gain. The method is one that benefits both wage-payer and wage-earner. Each, independently, has worked to reduce losses and wastes of materials, of supplies, of operation, of time, and they both share in the gain.

With the individual effort method the individual worker is rewarded in addition to his regular day wage. For instance, a time study is made of a particular piece of work upon which he is employed, and a schedule is made out and a reasonable standard time set such as any skilled man ought regularly to make. If the work is done in standard time the worker receives a 20 per cent. increase of pay above the hourly rate. He is paid this extra 20 per cent. not to work beyond reason, but to use his brains as well as his hands; to be his own foreman; to help keep conditions as they should be, and to assist the employer in maintaining high efficiency in tools and machinery. An illustration of the method used is indicated by the following diagram (Fig. 34) and table:

Hours to do Job.	Wages.	Bonus.	Wgs & Bonus.	Hrly rate of Man.	Mach. Cost.	Total Cost of Job.	Total Hourly Rate.
10	$2.40	.0	$2.40	0.24	$7.00	$9.40	0.94
9	2.16	.0	2.16	0.24	6.30	8.46	0.94
8	1.92	.0	1.92	0.24	5.60	7.52	0.94
7	1.68	.0	1.68	0.24	4.90	6.58	0.94
6	1.44	.0	1.44	0.24	4.20	5.64	0.94
5.8	1.39	.002	1.392	0.24	4.06	5.452	0.94
5.5	1.32	.010	1.330	0.242	3.85	5.180	0.942
5.2	1.25	.025	1.275	0.245	3.64	4.915	0.945
5	1.20	.039	1.239	0.248	3.50	4.739	0.948
4.9	1.18	.049	1 229	0.251	3.43	4.659	0.951
4.6	1.10	.084	1.184	0.257	3.22	4.404	0.957
4.3	1.03	.130	1.160	0.269	3.01	4.170	0.970
4	.96	.192	1.152	0.288	2.80	3.952	0.988
3	.72	.432	1.152	0.384	2.10	3.252	1.084
2	.48	.672	1.152	0.576	1.40	2.552	1.276
1	.24	.912	1.152	1.152	0.70	1.852	1.852
0	.0	1.152	1.152	Infinity	.0	1.152	Infinity

If the work is done in four hours, which is the standard time, the worker receives a 20 per cent. bonus. If more than four hours is used, and the work is finished in any time less than time and a half, or six hours, the worker still receives a bonus, depending upon the time which is taken. If more than six hours is used, the worker receives no bonus, but, of course, receives his day rate. If the work is done in less than standard time, the worker is given all the gain due to his own time. The employer gains the saving in the machine rate and surcharge, and the total cost of the job to him steadily decreases as the time required is reduced as indicated in the table. As it costs about $1 per hour to operate a man and machine, whether he works fast or not, the enormous economy of fast operation is apparent.

The following example taken from Mr. Emerson's paper shows clearly why it is to the employer's interest not to reduce the standard time so that it will be impossible for the worker to earn the 20 per cent. bonus:

"The worker wants to know, however, what is to prevent the employer from arbitrarily reducing standard time so that it will be impossible to earn 20 per cent. extra. The answer is that self-interest stands in the way, the self-interest of the employer, and this is the strongest protection of the worker. Nothing compels the employe to try to make standard time. If he does not think that he is treated fairly, he will not put forth the same effort, and the employer loses far more than he does. The schedules are intended to be as fair as they can be made. If found not to be fair, they should be revised and adjusted in the interests of both parties. For example: Standard time of turning locomotive drivers, four hours; man's rate, $0.30; extra pay per hour, $0.06; general expenses per hour, $0.60."

The cost at four hours:	
Wages	$1.20
Individual effort reward	.24
General expenses	2.40
Total	$3.84

"The employer reduces standard time to three hours, and the employe drops back to five hours. He can just as well do this, for he would make nothing extra at his former time of four hours."

Total cost at five hours:	
Wages at $0.30	$1.50
Individual effort reward	.00
General expenses	3.00
Total cost	$4.50

"Because standard time has been cut the employer loses $0.86 and the wage-earner loses $0.30. The proverb says any one can lead a horse to the trough, but it takes a wise man to make him drink. The employer can do his share, but his trouble and expense will be in vain unless he can induce the wage-earner to co-operate; and the cheapest, easiest method to secure and maintain co-operation is to offer an attractive increase of pay. Under no other system can the employe so effectively protect himself."

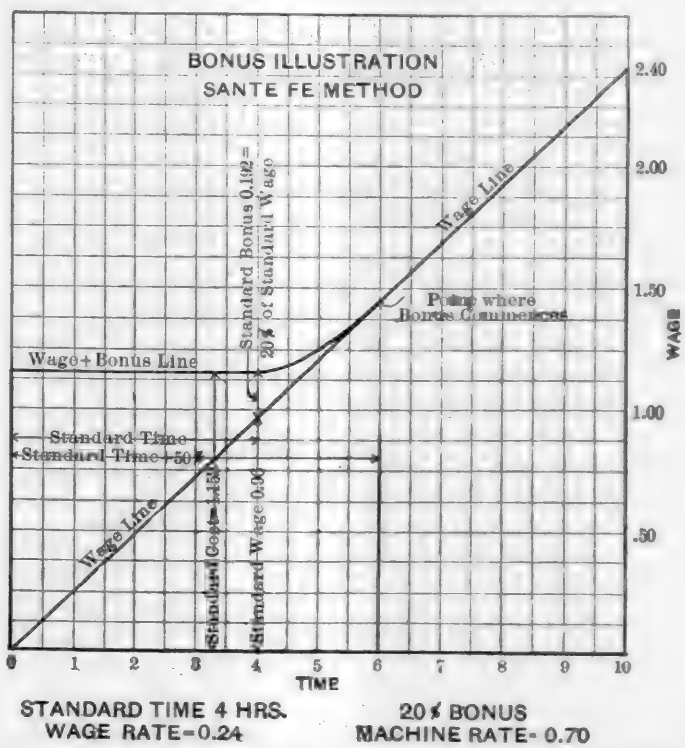

FIG. 34.—GRAPHICAL ILLUSTRATION OF INDIVIDUAL EFFORT METHOD.

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Output [illegible] costing each—		Per Cent.
[illegible]	[illegible]	55.3
[illegible]	98.23	15.7
[illegible]	181.50	29
Total	$625.56	100

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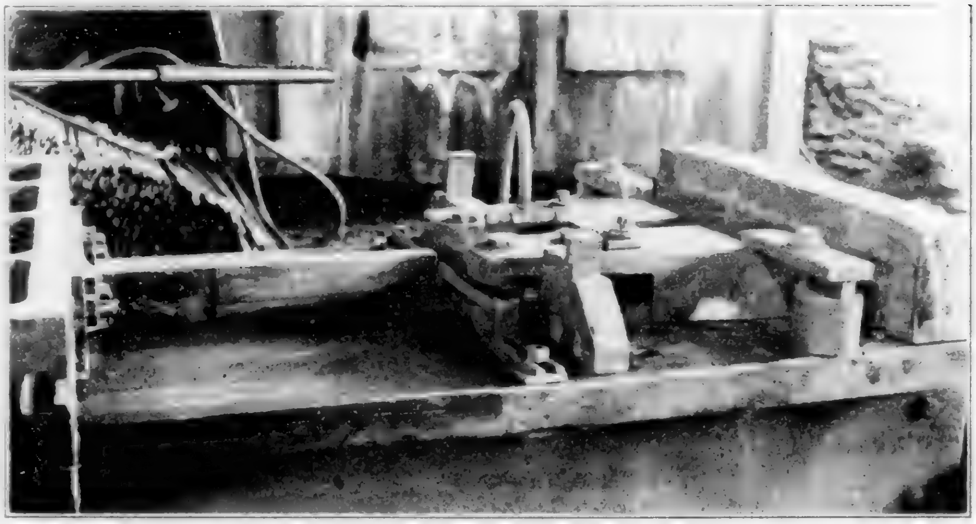

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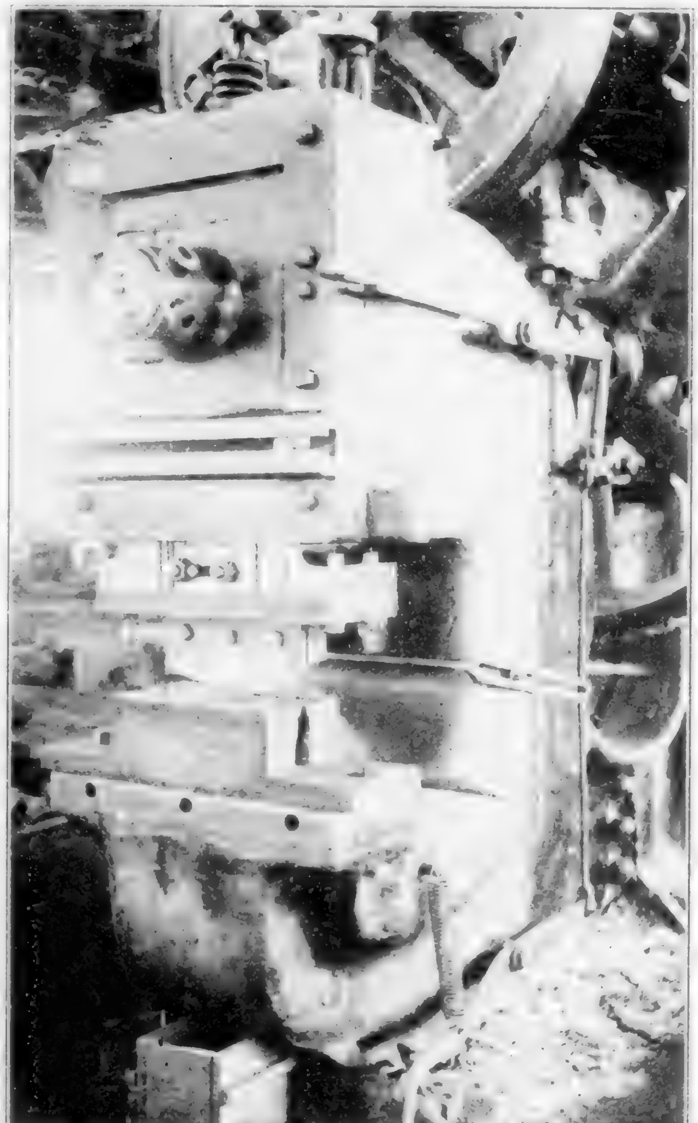

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4.3	1.03	.130	1.160	0.269	3.01	4.170	0.970
4	.96	.192	1.152	0.288	2.80	3.952	0.988
3	.72	.432	1.152	0.384	2.10	3.252	1.084
2	.48	.672	1.152	0.576	1.40	2.552	1.276
1	.24	.912	1.152	1.152	0.70	1.852	1.852
0	.0	1.152	1.152	Infinity	.0	1.152	Infinity

If the work is done in four hours, which is the standard time, the worker receives a 20 per cent. bonus. If more than four hours is used, and the work is finished in any time less than time and a half, or six hours, the worker still receives a bonus, depending upon the time which is taken. If more than six hours is used, the worker receives no bonus, but, of course, receives his day rate. If the work is done in less than standard time, the worker is given all the gain due to his own time. The employer gains the saving in the machine rate and surcharge, and the total cost of the job to him steadily decreases as the time required is reduced as indicated in the table. As it costs about $1 per hour to operate a man and machine, whether he works fast or not, the enormous economy of fast operation is apparent.

The following example taken from Mr. Emerson's paper shows clearly why it is to the employer's interest not to reduce the standard time so that it will be impossible for the worker to earn the 20 per cent. bonus:

"The worker wants to know, however, what is to prevent the employer from arbitrarily reducing standard time so that it will be impossible to earn 20 per cent. extra. The answer is that self-interest stands in the way, the self-interest of the employer, and this is the strongest [illegible] of the [illegible]. Nothing compels the employe to try to make standard time. If he does not think that he is treated fairly, he will not put forth the same effort, and the employer loses far more than he does. The schedules are intended to be as fair as they can be made. If found not to be fair, they should be revised and adjusted in the interests of both parties. For example: Standard time of turning locomotive drivers, four hours; man's rate, $0.30; extra pay per hour, $0.06; general expenses per hour, $0.60.

The cost at four hours:	
Wages	[illegible]
Individual effort reward	[illegible]
General expenses	[illegible]
Total	$3.84

"The employer reduces standard time to three hours, and the employe drops back to five hours. He can just as well do this, for he would make nothing extra at his former time of four hours.

Total cost at five hours:	
Wages at $0.30	$1.50
Individual effort reward	[illegible]
[illegible]	[illegible]
Total	[illegible]

"Because standard time has been cut the employer loses $0.86 and the wage-earner loses $0.30. The proverb says any one can lead a horse to the trough, but it takes a wise man to make him drink. The employer can do his share, but his trouble and expense will be in vain unless he can induce the wage-earner to co-operate; and the cheapest, easiest method to secure and maintain co-operation is to offer an attractive increase of pay. Under no other system can the employe so effectively protect himself."

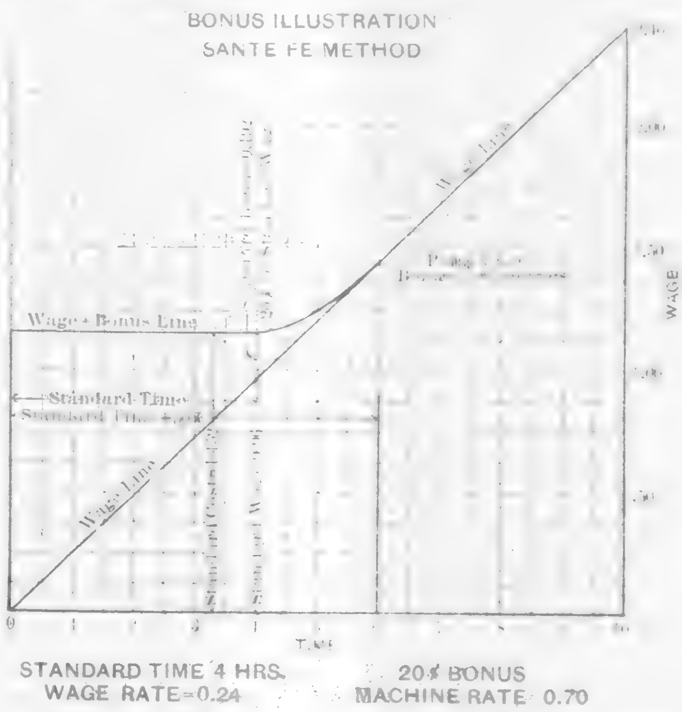


FIG. 34.—GRAPHICAL ILLUSTRATION OF INDIVIDUAL EFFORT METHOD.

The advantages of the individual effort method are also clearly summed up by Mr. Emerson as follows:

1. The standard time set is reasonable, and one that can be reached without extraordinary effort; is, in fact, such time as a good foreman would demand.
2. An extra reward of one-fifth of the regular wages for the operation is given to whoever makes standard time.
3. Extra compensation above the hourly rate is paid even if standard time is not reached, although this extra compensation diminishes in percentage above standard time.
4. If longer than time and a half is taken, the regular day rate is paid. Of this the wage-earner is sure.
5. Standard time is carefully determined by observation and experiment, and is only changed when conditions change.
6. The arrangement is one of mutual benefit to both parties—of increased earning to the worker, of increased saving to the employer.
7. The employer loses more than the wage-earner if schedules do not encourage co-operation.
8. The wage-earner, working on a schedule, becomes in a large degree his own foreman.
9. The wage-earner determines his own earning power, and by co-operating to cut out wastes increases his own value.

The direct results of shop betterment and individual effort are:

FOR THE EMPLOYE.

To shorten the hours of labor;
To enable each man to determine his own earning capacity;
To increase earnings;
To do away with overtime;
To make him self-reliant;
To add to his value as he grows older;
To add to his comfort and safety in the shop;
To harmonize relations with the employer.

FOR THE EMPLOYER.

To decrease the cost of production;
To lessen the delays on each job;
To lessen careless wastes and breakages;
To increase the output for the same investment of capital;
To secure a higher class of employes;
To harmonize relations with employes.

Application of the Individual Effort Method at the Topeka Shops.

The individual effort method was introduced gradually at the Topeka shops, the tools, machinery and shop methods first being improved to a high point of efficiency. At the present time the bonus system has been extended to all of the work in the erecting shop and to about 80 per cent. in the east machine shop, 50 per cent. in the west machine shop, 70 per cent. in the brass department, 75 per cent. in the smith shop, 5 per cent. in the tool room, 50 per cent. in the air pump and tinsmith's department; in the boiler shop only a small proportion of the work is bonused, largely because the gangs are small and the nature of the work is such that there is a continual shifting of the different members of a gang, making it almost impossible to place them on the bonus system.

The first step in drawing up a schedule is to make a careful time study under the general direction of a competent and trained man. An example of a time study is as follows:

15,66,08
Richard Roe, No. 0425.
Laying out and slotting brass and collar fit in new cast iron driving boxes, all boxes over 9 ins. brass fit; 20 per cent. steel cast iron:

	Actual Time		Estimated Time	
	Mins.	Secs.	Mins.	Secs.
Putting box on machine	—	35	—	35
Clamping down, setting box	8	02	5	—
Cutting	14	52	14	52
Turning tool around	—	42	—	42
Cutting	11	39	11	39
Changing tool, grinding	2	19	1	—
Cutting	2	56	2	56
Changing tool	1	56	—	42
Broken spring, time lost	46	20	—	—
Cutting	53	23	40	—
Changing tool and belts	1	15	1	—
Cutting	3	39	3	39
Changing tool	1	35	—	50
Cutting	5	3	3	39
Taking off box	3	32	2	—
Total	2 37	57	1 28	34

Standard time adopted, 1.5 hours.

The number of the machine is 15,66,08. Fifteen indicates the class of machine, 66 its location (east side of the machine shop, south end), 08 indicates that this is the 8th operation or schedule on this particular machine. The man's number is 0425, 04 indicating the shop in which he works. In making a time study the operator follows his usual methods. The expert, who is a practical machinist, is equipped with a stop watch, and carefully observes every operation, and makes a note as to the speeds, feeds, depth of cut, condition of machine, belts and tools, and from these observations a standard schedule is made up. In some instances it is, of course, advisable to have the specialist perform the work himself. Up to the present time about 4,000 time studies have been made at the Topeka shops.

It will be seen from the above time study that there is no change made in the time that the machine is actually cutting, but that all wastes are cut out. The time study is carefully checked by several different persons, and is usually compared with standard records of similar work or performances in other shops. When a time study is made and a standard time is decided upon, a bonus schedule is drawn up about as follows:

No. 156,608.

INDIVIDUAL EFFORT SCHEDULE.

For laying off and slotting for brass and cellar fit cast iron, 20% steel driving boxes; all boxes over 9" brass fit.

Machine slotter No. 1566. Hourly rate, $0.50.

Tools, blue chip steel. Workman's rate, $0.25 per hour.

Time.	*Wages.*	*Bonus.*	*Total to Man.*	*Rate Per Hour.*
2.25	.5625	.0	.5625	.25
2.2	.55	.002	.552	.251
2.1	.525	.006	.531	.253
2.	.50	012	.512	.256
1.9	.475	.02	.495	.261
1.8	.45	.03	.48	.267
1.7	.425	.042	.467	.275
1.6	.40	.057	.457	.286
1.5	.375	.075	.45	.30

Remarks: ....

Checked by ....
Supt. of Shop.

....
Shop Expert.

Approved by ....
March 1st, 1905. Supt. Motive Power.

On the contract given the operator, only the first and third columns appear, as it is these that he is most interested in.

Before the schedule can be placed in operation it must be checked by the shop superintendent and the shop expert, and must be approved by the superintendent of motive power.

"The schedule is a moral contract or agreement with the man as to a particular machine operation, rate of wages and time. Any change in man, in his wage rate, in the machine, or in the operation, calls for a new schedule. If a schedule proves too low, it is raised; if it proves too high, the insignificant loss is temporarily suffered by the company. The moral contract with the man should never be violated."

The foremen, as well as the men, are bonused. Following is the schedule for the machine shop foremen:

SCHEDULE FOR GENERAL MACHINE SHOP FOREMAN AND FOREMEN OF EAST AND WEST SIDES OF MACHINE SHOP.

Bonus to be paid, based on the number of engines turned out per month and engine equivalent of manufactured material shipped.

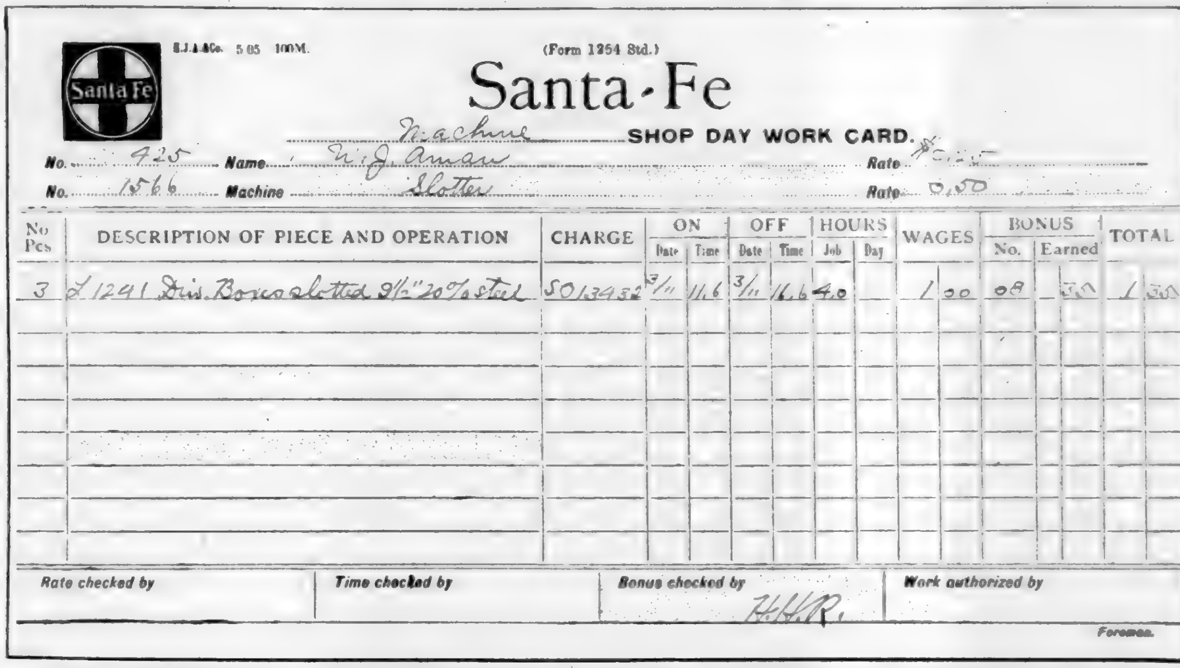
A standard time to be assigned for all work done on each manufactured article finished in these departments; this time to be taken from individual effort schedules, where possible, and estimated in other cases.

The total average number of hours per engine for all labor in these departments to be determined by the preceding month's records of engines repaired.

Total number of hours devoted to manufactured material shipped, divided by average hours per engine, will give engine equivalent of manufactured material.

Manufactured material reduced to engine equivalents added to shop output of engines determines number of engines on which bonus will be paid.

For each engine, and fraction thereof, completed during the month, a bonus of $1.40 will be paid, divided among the foremen


S.J.A.&Co. 5 05 100M. (Form 1254 Std.)

Santa-Fe

Machine SHOP DAY WORK CARD.

No. 425 Name W. J. Aman Rate

No. 1566 Machine Slotter Rate 0.50

No Pcs	DESCRIPTION OF PIECE AND OPERATION	CHARGE	ON Date	ON Time	OFF Date	OFF Time	HOURS Job	HOURS Day	WAGES	BONUS No.	BONUS Earned	TOTAL
3	L 1241 Dis. Boxes slotted 9½" 20% steel	5013432	3/11	11.6	3/11	11.6	4.0		1 00	08	30	1 30

Rate checked by | Time checked by | Bonus checked by H.H.R. | Work authorized by

Foreman.

FIG. 35.—TIME DISTRIBUTION CARD (ON MORE RECENT CARDS PROVISION IS MADE FOR CHECKING IN AND OUT BY TIME CLOCK ON ONE END OF CARD).

as follows: General machine shop foreman, 45 per cent.; east and west side machine foremen, 27½ per cent.

For each day any machine work is delayed beyond date set for same on erecting floor schedule, a deduction of three cents per engine will be made from the bonus earned by machine foreman causing the delay and that of general machine shop foreman.

For each day engine machine work is completed in advance of schedule date, an additional bonus of three cents per engine will be added to bonus earned by general machine shop foreman and machine foreman to whom advance is credited.

Bonus account will be settled monthly.

In the erecting shop the same principle is used, although its application is modified to suit conditions, and possbly it can best be described by reproducing a schedule used by one of the erecting floor gangs:

LINK GANG.

No. 0000-18.

For repairing and putting on engines as they pass through the shops for repairs: Links, blades, motion bars, tumbling shaft, rocker shaft, boxes, reverse lever, reach rods, quadrant, all stands, hangers, brackets, bolts, bushings, bearings or boxes, balance springs, machine work and connections for above, and all necessary work to put them in first-class condition.

Standard clauses as herewith apply:

Standard wage cost of gang per 50 hours, $180.
Standard wage cost per hour, $3.60.

Gang output Per week of 50 hours.	When gang cost is $180.00 bonus will be	When gang cost is $170.00 bonus will be
5 engines	$0.00	$2.50
6 engines	10.80	14.40
7 engines	21.60	28.80
8 engines	32.40	43.20
9 engines	43.20	57.60
10 engines	54.00	72.00
11 engines	64.80	86.40

STANDARD CLAUSES FOR GANG 18.

GANG AND FOREMAN.

The company will pay a bonus as provided herewith to the foreman and men composing this gang, provided the minimum of five engines is turned out each and every week during the month:

Engines will be counted when the work is completed satisfactorily to the foreman.

Engines will not be counted: (1) when the work is improperly done; (2) if overtime has been worked; (3) if needed to make up any deficiency below five engines in final total for each preceding week of the month.

On the minimum output of five engines per week, 25 per cent. of any reduction in wage cost of gang below allotted wage cost will be allowed to the gang as a bonus. For any output in excess of the minimum, bonus as provided by the table herewith will be paid, and for each dollar reduction in labor cost of gang below allotted cost 3 1-3 per cent. of the bonus fixed by the output for the week will be added to that bonus and the whole divided as provided by schedule.

If the wage cost exceeds the allotted cost, no bonus will be paid. A fresh start, with no arrears to make up, will be made the first week of every month.

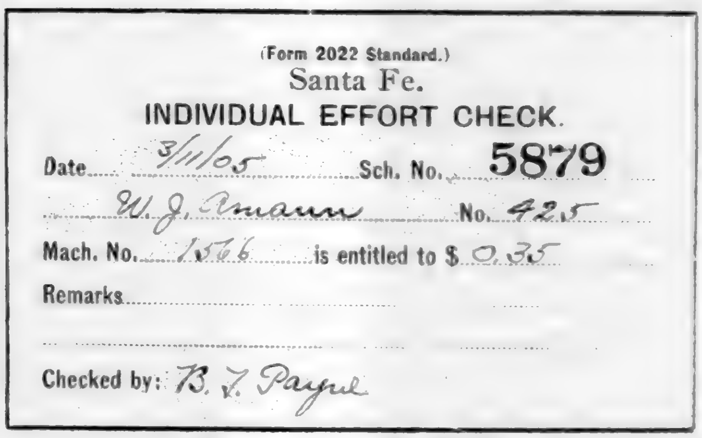
Bonus as thus provided for in schedule will be divided among foreman and men working in gang in proportion to their wages and time worked.

FOREMAN.

In addition to such bonus as the foreman may earn, as provided above, for each engine turned out satisfactorily on or before the date as set for same on erecting floor schedule, a bonus will be paid, as follows:

(1) For completing all bench work of the link gang, $0.25 for each engine.

(2) For hanging motion work on an engine complete, ready for valves to be set, $0.15 for each engine.


(Form 2022 Standard.)

Santa Fe.

INDIVIDUAL EFFORT CHECK.

Date 3/11/05 Sch. No. 5879

W. J. Amann No. 425

Mach. No. 1566 is entitled to $ 0.35

Remarks

Checked by: B. T. Payne

FIG. 36.—INDIVIDUAL EFFORT CHECK.

(3) For putting up rocker boxes, rocker shafts, tumbling shaft, and tumbling shaft boxes, reach rod, quadrant and reverse lever on an engine, $0.10 for each engine.

(4) For each day the above work is completed in advance of or delayed beyond the date set for same on schedule an addition to or deduction from the total bonus earned by foreman for the month will be made as follows:

Clause No. 1, $0.08 for each day.
Clause No. 2, .05 for each day.
Clause No. 3, .04 for each day.

(5) Engines passing through shop on schedule time, on which no link gang work is to be done, will be figured as completed on time, and clauses Nos. 1, 2 and 3 will apply.

(6) When roundhouse work, after trial trip, requires more than one day to complete, such delays will be counted against foreman

and a deduction of 17 cents for each day will be made from the total bonus earned by the foreman for the month.

(7) When work cannot be completed within allotted time on account of being delayed by other gangs, or by storehouse, such interval of delay will not be considered in figuring bonus.

bonus card. By comparing these two cards with the time distribution card shown in Fig. 35 the scheme of punching them may readily be seen. There is a hole in every column except where the top X is punched, in which case the whole

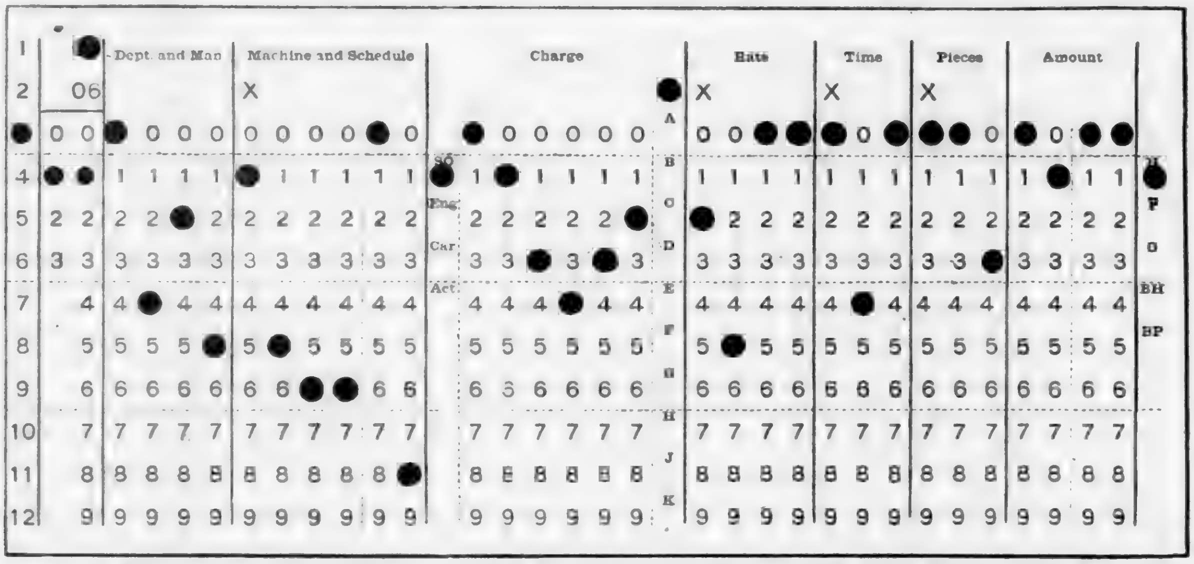


FIG. 37.—LABOR CARD USED WITH HOLLERITH TABULATING MACHINE. (BLACK SPOTS INDICATE HOLES PUNCHED.)

field is skipped. The date 3—11—05 is punched by a gang punch, a large number of cards being punched at the same time. The man's number is 0425, and indicates his hourly rate as well as his number. The schedule number 15,66,08 indicates the kind of machine, the machine location and schedule. The work is charged to Shop Order No. 13432. The man's rate is 25 cents, the time taken is four hours, the number of pieces three and wages paid $2.

The bonus card is similar, except that it shows the bonus earned, 35 cents. A distribution card will show an average of three operations per day, requiring six of these cards. The operation of punching is a simple one, and requires less time than if the records were to be entered in a book or on a sheet. One man can punch from 1,500 to 3,000 cards per day.

The second operation is to sort the cards into groups. Suppose, for instance, that it was desired to tabulate the cards according to different shop orders. The cards would be fed into the machine and sorted at the rate of about 200 per min-

Each workman has a time distribution card, as shown in Fig. 35, provision being made for checking in and out on the end of the card. The timekeepers enter upon these cards the necessary information as to the work done by each workman, and from this the bonus is calculated. At the present time seven timekeepers are required, one in the erecting shop (about 200 men), three in the machine shop, or one to about 60 men, two in the boiler shop, and one in the blacksmith shop (about 160 men). As will be seen later, the timekeepers in the machine shop assist quite materially in making it possible to control the shop from a central station. Every morning the worker is given what is known as an individual effort check, Fig. 36, showing the amount of his bonus for the previous day, and is thus encouraged in his work.

Tabulating Records.

Hollerith tabulating machines, developed by Dr. H. Hollerith, and used for tabulating census records, are used by the accounting department in calculating the wages and bonus for

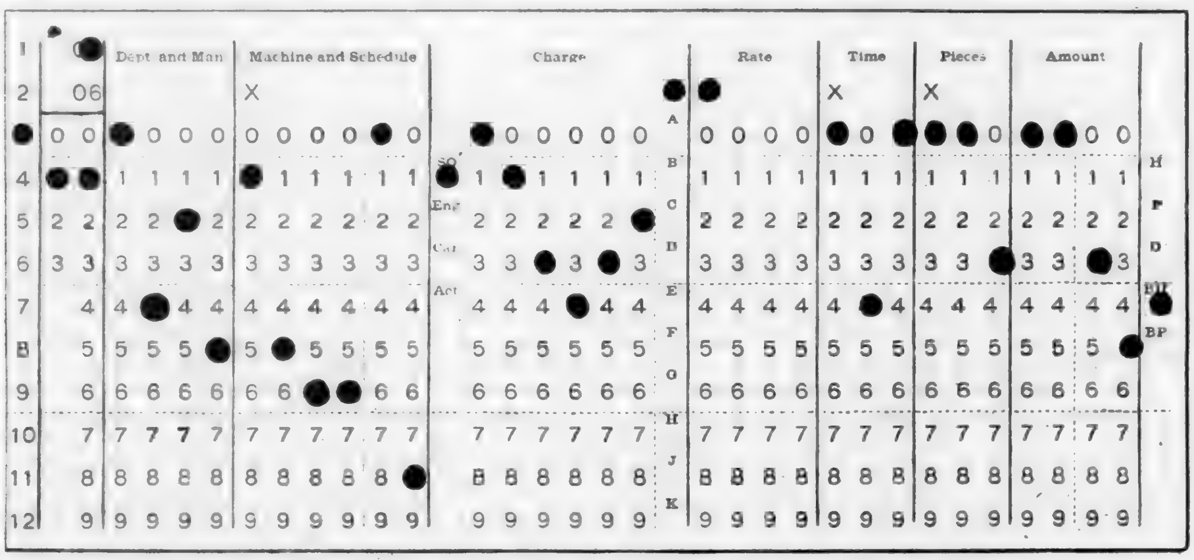


FIG. 38.—BONUS CARD USED WITH HOLLERITH TABULATING MACHINE.

each man or in finding the amount to be charged to different engines or shop orders or any other information of this kind.

In tabulating records by means of these machines three operations are necessary. In the first place cards similar to those shown in Figs. 37 and 38 must be punched. The first of these cards is known as a labor card and the second as a

ute. They could then be run through a tabulating machine at the rate of 40 or 50 cards a minute, and the time or cost on a particular order could quickly be obtained. By means of these machines it is possible to determine quickly and accurately information concerning almost any operation or phase of the work.

If desired, a third card may also be made out, preferably of a different color, to show the machine charge for each piece of work. An idea of the wide range of work which may readily be done on these machines with the three sets of cards described above may be gained from the following extract from one of Mr. Emerson's reports:

What do these cards give us? Almost every possible fact wanted. They are sorted by a machine and tabulated also by a machine. Assume 200,000 cards recording a month's work. The following questions are propounded for answer:

(1) What was total number of hours worked by all operators? Run all the work cards through tabulating machine set for hours.

(2) What is payroll for each group? Sorting machine is set for the different groups and cards run through, thus being sorted into piles corresponding to groups or shop subdivisions. Each pile is run separately through the tabulating machine, which thus gives payroll for each group. These are then reduced to hour basis and entered on comparative sheet of previous month and year.

(3) What is total payroll for month? Add the totals of groups together.

(4) What is due each man? Take group piles and sort according to men, then tabulate.

(5) What were total machine earnings in each group? Take machine cards, sort by groups, and tabulate.

(6) What were total machine earnings? Add earnings of each group.

(7) How shall machine earnings be distributed? From group earnings to various accounts: so much for power, depreciation, etc.

(8) How many hours did all the machines work? Tabulate all machine cards on hours. This will enable good estimate to be made as to needs of new machines.

(9) How many hours did each machine work? Sort according to machines.

(10) How many different jobs did certain men do? Sort either on machine or by shuffling the pile of the individual man.

(11) How many men worked on same machine job? Sort machine cards or men's cards as to jobs and make comparisons. As cost of same work varies 100 per cent. with different men on it, this is an important possibility.

(12) How many different kinds of jobs did certain machines do? Shuffle the cards of the machine according to the jobs.

(13) On how many different machines was the same job done? Sort as to job; but more quickly determined by picking out specific cases as to two or more known machines. The object is to know whether a job is done more cheaply on one machine than on another.

(14) What was the total of all the charges against a given repair job, say, locomotive 256? Run through sorting machine (set for 256) all the cards that are likely to include this job, and tabulate.

(15) What were the direct charges? Tabulate the sorted labor cards.

(16) What were the bonus charges? Tabulate the sorted bonus cards.

(17) What were the machine charges? Tabulate the sorted machine cards. These sortings and tabulations can be used to determine the exact cost of each operation.

(18) How many hours did the men work on the 256 locomotive repair job? Tabulate the men's cards by hours.

(19) How many hours did the machines work? Tabulate the machine cards by hours.

(20) What men worked? List them from the sorted cards.

(21) What machines worked? List them from the sorted machine cards.

(22) Without having kept any records other than the punched cards, in a few hours one can ascertain the cost during the month to date on any particular piece of work.

When the work which is handled by these machines is considered, it is remarkable that so small a force is required. The visit to Topeka was during the early part of the month, and a large amount of work was required in order to finish up the monthly records. There were only three young men employed in this department. There were two sets of punches, so that two of them could punch cards at the same time, if desired. There were two sorting machines and two tabulating machines, and the rate it was possible to punch, sort the cards and tabulate any number of them to obtain various data was remarkable and almost inconceivable. The force which would be required to do the same amount of work by ordinary means would be many times greater. The machines, of course, furnish absolutely accurate results, providing the cards are properly punched.

Cost Accounting and the Surcharge Problem.

The following account of the cost accounting is taken from a description of the betterment methods in operation at the Topeka shops in a report made by Mr. Emerson to Mr. J. W. Kendrick, second vice-president.

It should, however, be kept clearly in mind that cost accounting is a part of shop practice and not necessarily of auditing interest. From the shop point of view, in order to compare its own costs at different periods, or with costs at other shops with the prices at which material can be purchased, all the elements of rent, machine charge, power and supervision should be determined for each operation.

* * * * * * * * * *

The usual methods of determining costs are not as good as sensible guesses, and require most cumbersome systems, which have justly brought the whole idea of accurate cost determination into disrepute. An adequate cost system must fulfill several requirements. It must be exceedingly simple, yet reliable. It must give promptly all the information required. It must make greater efficiency or excellence easy and pleasant, laxity and inefficiency very disagreeable. But reliably accurate, very suggestive and immediately available cost determinations can be secured almost incidentally and without effort.

All that is necessary is to determine (1) the machine-hour rate and (2) that part of general expense to be assessed as a per cent. of wages against each sub-group of men, and the problem is solved for all time. To do this initial work well requires considerable experience and judgment, but when it has once been done the system is simplicity itself. The method of doing this will, as to shops similar to those of the Santa Fe at Topeka, be fully described.

In a large shop spending $240,000 a month:

Materials used amount to		$120,000
Direct labor		74,470
Supervising and assisting labor	$21,855	
Materials for supplies, operation and maintenance	12,349	
Book account charges (mainly interest and depreciation)	11,326	45,530
		$240,000

Certainly enough is paid for administration and operating charges to call for the highest efficiency. Usually, records and accounting are full and complete as to totals, but they exist in most fragmentary and unreliable shape as to details. Materials are indeed drawn on requisition and men are checked in and out, but what actually becomes of the material issued or of the day checked, is at best only approximately known, and approximations are of small value for shop betterment endeavors. The Mississippi flows approximately south, but this fact is of small use to the pilot who wants to know the exact location of every bar and snag.

Man and Machine Surcharges.—In every shop there are general expenses, and there is little question as to their aggregate amount. It has thus far proved almost impossible to distribute them properly to each separate operation. The fear of the detail work that might be necessary has hitherto deterred both accountants and shop managers from attempting cost determinations as a regular part of daily duties, but the time-distribution record of shop operation, as well as the Hollerith methods of sorting and tabulating, make an accurate determination easy and quick.

All general expenses can be apportioned for convenience to the four heads:

Rent	$8,000
Supervision	14,530
Maintenance and operation of equipment	18,200
Power (light, heat, water, etc.)	4,800
	$45,530

These items are in detail, subject to revision and change. No two specialists would ever wholly agree as to exact apportionment of power, or rent, or maintenance, or supervision.

The same subdivisions are followed with each separate shop and subdivision of shops. The two main subdivisions at Topeka are the locomotive and car departments.

	LOCOMOTIVE SHOP.		CAR SHOP.		TOTAL.
	Men.	Machines.	Men and Machines.	Sundries.	
Rent	$2,925	$2,075	$3,000	......	$8,000
Supervision	8,595	85	5,850	......	14,530
Maintenance	3,229	8,271	6,700	......	18,200
Power	789	2,846	793	$372	4,800
	$15,538	$13,277	$16,343	$372	$45,530

The distribution of these four items of general expense is shown in the three following tables, apportioned not only to the main departments and their subdivisions, but also in the locomotive shop to man and machines.

No very grave error would have been committed, had the general expense been assigned one-third each to men in the locomotive shop, machines in the locomotive shop, and to the car shop. As to the locomotive shop, the general expense might have been apportioned equally to the men and to the machines. In making the distribution, rent has been apportioned to each equally, except for those buildings or parts of buildings occupied exclusively by men. Power, and also small tools used on the machines, have been charged to machines.

Light and heat, as well as air tools, have been charged to the men. Supervision has been to, perhaps, an undue degree charged to men, but this item includes all the general labor not easily distributable to special jobs.

The division above made is a first approximation only, to be corrected as additional facts are gathered. It is a matter of, at most, a day's work for one accountant to distribute to machines and men groups any changed apportionment that may be decided on. So simple is the work that I should not hesitate to advise revising the surcharges and machine rates monthly, or at least quarterly, until uncertainty has been eliminated, basing each monthly rate on the average of the preceding twelve months, thus again, by gradual approximations, reaching ideal accuracy.

The percentage column ending each table is the valuable part of the whole work. As to men in each group, it shows just what percentage must be added to their wages to cover the general expenses as to men.

As to machines in each group, it shows just what percentage

DISTRIBUTION OF MONTHLY GENERAL EXPENSE IN CAR DEPARTMENT.

	(1) *Pay-Roll Direct Labor.*	(2) *Payroll Surcharge Labor.*	(3) *Rent.*	(4) *Supervision.*	(5) *Maintenance and Operation.*	(6) *Power.*	(7) *Total General Expenses, (3, 4, 5 and 6).*	(8) *General Expenses and Surcharge Labor to be Charged as per cent. to Direct Labor, (2 and 7).*	(9) *Total Expenses, (1, 2 and 7).*	(10) *Per Cent. of General Expense to Direct Labor.*
Planing Mill	$3,100	$500	$500	$940	$2,095	$450	$3,985	$4,485	$7,585	145 %
Freight Cars	14,200	1,050	600	1,455	715	25	2,795	3,845	18,045	25 %
Coach Shop	6,100	500	500	590	210	7	1,307	1,807	7,907	30 %
Paint Shop	4,500	150	800	260	115	6	1,181	1,331	5,831	30 %
Wheel Shop	2,400	300	100	350	1,530	195	2,175	2,475	4,875	100 %
Upholstery Shop	400	25	50	110	45	5	210	235	635	60 %
Cabinet Shop	3,000	300	400	590	525	100	1,615	1,915	4,915	65 %
Plating Shop	250	25	50	105	65	5	225	250	500	100 %
Total	$33,950	$2,850	$3,000	$4,400	$5,300	$793	$13,493	$16,343	$50,293	50 %

DISTRIBUTION OF LABOR, MONTHLY GENERAL EXPENSES IN LOCOMOTIVE SHOP.

SHOPS.	(1) *Payroll of Direct Labor.*	(2) *Payroll of Surcharge Labor.*	(3) *Rent.*	(4) *Supervision.*	(5) *Maintenance.*	(6) *Power.*	(7) *Tool Room as Surcharge.*	(8) *Total General Expenses, (3, 4, 5, 6, and 7.)*	(9) *General Expenses and Surcharge Labor to be Charged as Per Cent. to Direct Labor, (2 and 8.)*	(10) *Total Expenses, (1, 2 and 8.)*	(11) *Surcharge Per Cent. on Direct Labor.*
Erecting Floor	$13,900	....	$850	$1,095	$2,385	$259	$130	$4,719	$4,719	$18,619	35 %
East Side Machine	3,700	$1,110	180	1,985	45	70	....	2,280	3,390	7,090	90 %
West Side Machine	1,600	480	180	1,135	80	25	....	1,370	1,850	3,450	85 %
Brass Room	1,400	175	50	535	40	8	....	633	808	2,208	45 %
Tool Room	1,000	100	40	430	20	8	....	498	598	1,598	50 %
Air Room	750	....	20	145	15	8	5	193	193	943	25 %
Boiler Room	9,550	185	905	1,325	100	100	35	2,465	2,650	12,200	25 %
Forge Room	6,800	500	600	1,400	285	300	....	2,665	3,165	9,965	40 %
Pattern Shop	620	80	50	310	115	8	....	483	563	1,183	80 %
Tin Shop	1,200	50	50	235	114	3	5	407	457	1,657	35 %
Total	$40,520	$2,680	$2,925	$8,595	$3,229	$789	$175	$15,713	$18,393	$58,913	45 %
General Expenses exclusive of Tool Room.								$15,538.			

DISTRIBUTION OF MONTHLY MACHINE GENERAL EXPENSE IN LOCOMOTIVE SHOP.

SHOPS.	(1) *Value of Productive Machine.*	(2) *Value of Unproductive Machines.*	(3) *Rent.*	(4) *Accounting.*	(5) *Maintenance and operating.*	(6) *Power.*	(7) *Tool Room as Surcharge.*	(8) *Total General Expenses per month, (3, 4, 5, 6 and 7.)*	(9) *Total Surcharges per year.*	(10) *Percent of Surcharge to value of Productive Machines.*
East Side Machine	$50,000	$4,000	$180	$30	$2,765	$280	$150	$3,405	$40,860	80 %
West Side Machine	57,000	11,000	180	10	1,530	144	25	1,889	22,668	40 %
Brass Room	16,000	2,000	50	10	715	32	80	887	10,644	70 %
Tool Room	8,200	2,000	40	5	310	20	....	375	4,500	55 %
Air Room	1,500	1,000	20	5	155	22	5	207	2,484	170 %
Boiler Shop	43,000	18,000	905	15	1,545	1,390	10	3,865	46,380	110 %
Forge	45,000	9,000	600	10	1,050	934	....	2,594	31,128	70 %
Pattern Shop	2,500	1,500	50	....	170	20	....	240	2,880	100 %
Tin Shop	1,000	2,300	50	....	31	4	5	90	1,080	110 %
Total	$224,200	$50,800	$2,075	$85	$8,271	$2,846	$275	$13,552	$162,624	75 %
Total Surcharges exclusive of Tool Room.								$13,277.		

of the inventory value must be charged annually to cover the general expenses as to machines.

The hourly rate of a machine is ascertained by looking up its inventory value, multiplying this by the per cent. of surcharge determined for that group and dividing by the number of hours it is used in the year.

To illustrate: A man on the east side of the machine shop, whose wages are $0.30, works four hours on a machine whose inventory value is $5,000, and which is in use 2,000 hours in the year.

What is the cost of operation, exclusive of material?

Wages, 4 hours at $0.30	$1.20
General expenses as to man, 60 per cent. on wages	.72
Yearly machine rate, 80 per cent. of $5,000, or $4,000; working 2,000 hours, hourly rate $2	8.00
Total	$9.92

The operation cost of each and every job should include the three items: labor, general expenses as to man, and general expenses as to machines. As a book account, these items should be credited each month, wages to direct payroll account, the two other items in percentages to the different accounts of rent, supervision, maintenance and operation, and power.

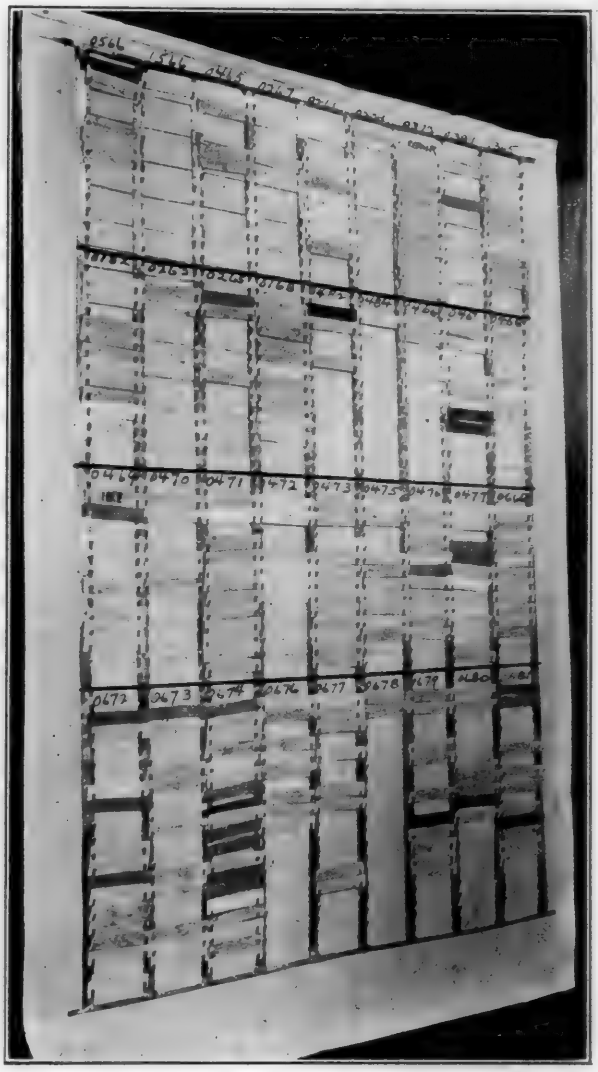


FIG. 39.—MACHINE SHOP DISPATCHING BOARD.

To what extent these various funds and apportionments to them shall be subdivided is an unimportant question of detail, to be decided according to circumstances. All rent earnings can be credited to the total rent charges, or the rent earnings of each department can be credited to the specific charges against that department.

There is very little question but that the greater accuracy, if its lessons were consistently followed up, would abundantly pay. It is not unimportant, on the contrary vitally important, to ascertain that in one department rent is the heaviest charge; in another, maintenance; in a third, power. In the boiler shop, for instance, power costs $1,390 a month, or 14 per cent. of the active payroll of $9,950. On the erecting floor, maintenance of equipment (air tools) is $2,385, or 17 per cent. of the active payroll of $13,900. In the boiler shop, $1,000 a month might have been saved, had it been known that certain machines were exceedingly expensive as to power, and on the erecting floor $1,000 a month can probably be saved by careful supervision over small tools and their repairs.

In shops, thousands of dollars melt away in cents and dimes. The object of modern shop accounting is not only to follow the equivalent of every cent into output, but also to be able to make comparisons and discover leaks. It is just as important to adopt a method that is $0.10 cheaper than another method as to avoid paying a man $0.10 too much.

[This question of surcharges in a railroad shop was quite thoroughly treated in an article by Mr. J. C. Morrison, material supervisor at the Topeka shops, on page 376 of our October issue. Several communications concerning this article appeared in our November issue, and replies to these will be found on another page of this issue, including a more complete description of the method of determining the surcharge.]

It is not essential that auditors should take any notice of these costs. It may satisfy them to charge merely direct labor and material, covering the other charges in some different manner. So entirely distinct are *shop costs* and *auditing charges* that the former should be standardized and entered up *before* a job is begun. The former are for the information of shop superintendent and other officials and determine shop, foreman and mechanic's efficiency.

Control of the Machine Shop from a Central Station.

Imagine, if you can, how the trains on a large railroad system would get along if it was attempted to operate them without a train dispatcher. If engines are to be repaired in a shop in a minimum amount of time, it is just as necessary to have the work drected from a central station, rather than by a "hit and miss" method. One of the most interesting features in connection with the Topeka shops is the fact that the general machine shop foreman directs the work of the shop from his office, and seldom finds occasion to leave it. Splendid results are being accomplished. The method of doing this was evolved and perfected by Mr. Clive Hastings, assistant to Mr. Emerson.

The foreman sits in a revolving chair; before him is a desk with two telephones, one connecting to the east and one to the west machine shop. Near the desk is another telephone, connecting with the office of the general foreman. On the opposite side of his chair from the desk are three dispatch boards, similar to the one shown in Fig. 39. These are about 4 ft. wide by 6 ft. high and are divided into a number of divisions, the arrangement of which is more clearly shown in Figs. 40 and 41. The number at the top of each division is that of the machine; for instance, 0475 would be a lathe in the east machine shop. The first two numbers indicate the type of machine and the last two its position in the shop. The general machine shop foreman is, of course, familiar with the exact location of each machine in the shop and the work for which it is best adapted.

When a foreman finds that a certain piece of machine work is necessary, he fills in a requisition and sends it to the office of the general machine shop foreman. This requisition shows the shop order on which the material is to be used. The general machine shop foreman immediately makes out a slip, about 4½ ins. long by ⅞ in. wide, showing the number of pieces and the name of the part wanted, the shop order number, and the machine upon which the work is to be done. This small slip is then placed on the dispatch board underneath the number of the machine. If new material is required for an engine in the shop, a blue slip is used. If the material is for a new switch engine, some of which are being built at the Topeka shops, it is placed on a yellow slip. Rush or emergency orders are placed on red slips; repair material for engines in the shop on white slips; a shop order for the system on green slips, and repairs to machinery on pink slips.

By looking at the dispatching boards the foreman, knowing what work is to be hurried or is of the greatest importance, can quickly decide the next job to be done on any one of the machines. The slip at the head of the column, immediately under the machine number, indicates the piece of work in the machine. Shortly before this work is finished, the machine operator advises one of the timekeepers, or the foreman, and they telephone to the machine shop foreman and ask for instructions as to the next piece of work. By means of a messenger (two boys are employed), the order for the next job is sent to the machine operator in sufficient time, so that he need lose no time waiting for instructions or for the proper material.

It will be seen that there are six spaces under each machine number, corresponding to the number of working days in a week. As soon as a job is finished, the small slip is removed from the board and the information on it is copied in the proper division in the column. At the end of the week it is, of course, necessary to put a new piece of paper on the board, the old piece being removed and kept on file. A complete record of all the work done on every machine in the shop is thus available, and may readily be referred to, if desired.

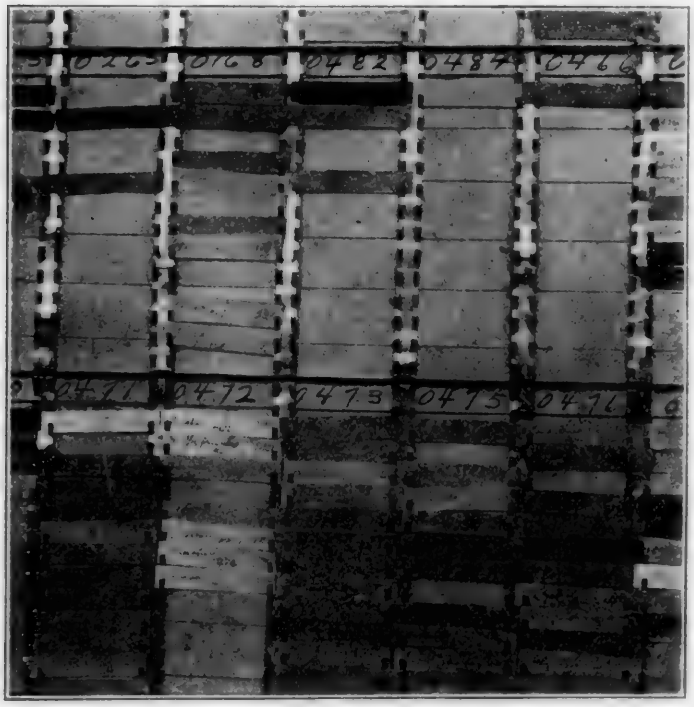


FIG. 40.—PARTIAL VIEW OF MACHINE SHOP DISPATCHING BOARD.

It is quite possible that the reader will smile as he reads this description. Several shop managers smiled quite broadly when they were told of it. It does sound like a Utopian scheme. Its effectiveness, however, is readily apparent by sitting down and watching operations in the office for half an hour or so. The general machine shop foreman is a busy man. Reports are continually coming in to him, either over the telephone or by messenger, and it keeps him pretty busy giving the necessary instructions as to the work to be done. It has been said that it is impossible for the foreman to accomplish results unless he goes out through the shop, but here we find a man who is perfectly familiar with every machine in the shop, has at hand the schedule showing exactly what work is to be done on each engine for each day it is in the shop, and he utilizes every moment of his time in planning and arranging the work. No time is lost in going from point to point in the shop.

Under the bonus system the men are anxious not to waste time, and in order to accomplish results they must have the work at their machines and ready to be put into place as soon as the previous piece of work is completed. This system of control forms an ideal method of accomplishing this result. It took some time to develop it and get it into its present form. At first, the method of using colored strings, such as used in a train dispatcher's office, was tried, but this method was found rather cumbersome and hardly fitted for a machine shop, and the present arrangement was devised.

The vertical strips are of tin with projections or clips behind which the slips can easily be dropped. The cross strips, to which these pieces of tin are soldered, are of heavy wire.

Material on store orders is not ordered from the storehouse until just before the machine is ready for it, in order not to litter the shop with surplus material. For machines that are laid up for repairs, or on which no operator is working, a slip is placed just underneath the number of the machine, marked "idle" or "repairs."

This plan may look theoretical and encumbered with red tape. One might expect to find the general machine foreman in this position, a visionary, over-educated theorist, instead we find in Mr. W. L. Jury, who now holds this position, a thoroughly practical mechanic, who was formerly an efficient foreman of the east machine shop.

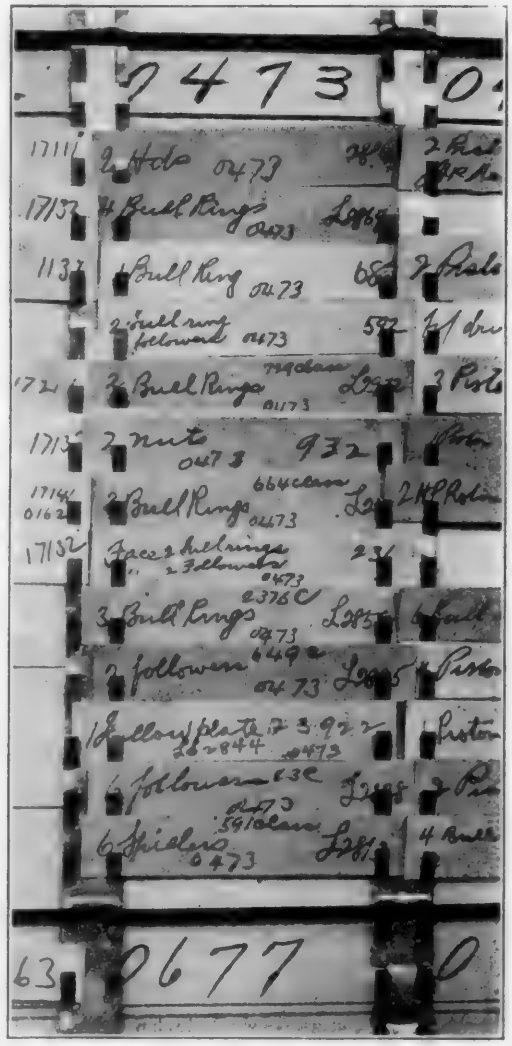


FIG. 41.—DETAIL OF DISPATCHING BOARD.

Inspection of Engines and Work to be Done on Them.

When a master mechanic sends an engine to the shop he forwards a report to the shop superintendent as to its condition. When the engine reaches the hospital track, the inspector looks over the master mechanic's report, examines the engine, and makes out what is known as a "conditional" report, showing the condition of the more important parts of the locomotive, such as the firebox, flues, smoke arch, driving-wheel centers and tires, frames, crossheads and tender. This report, while, of course, only of a general nature, enables the shop superintendent, if there are several engines on the hospital track, to select the one which may be handled to the

best advantage in the shop at that particular time. For instance, if several engines are already in the shop requiring new fireboxes, it would not be desirable to place in the shop other engines requiring much work of this kind. In order that the shop may be brought to a high point of efficiency and economy, it is, of course, necessary to keep conditions as uniform as possible.

When the engine is placed in the shop for stripping, the inspector marks those parts which are to be stripped, at the same time dictating to a stenographer an exact statement of the work to be done by the stripping gang. By the time this report is written out, the stripping gang is usually just finishing its work, and the gang foreman goes over the statement and checks to make sure that the work has been properly done. As the engine is being stripped, the inspector carefully examines the various parts and prepares a detailed statement of just what work is to be done on the engine by each gang. A sample of one of these reports, and also a list of the different gangs in the shop, is given in Mr. Morrison's article on "The Locomotive Repair Schedule," on page 339 of our September issue. No work must be done on the engine or material used other than that called for in the inspector's statement, unless authorized by the shop superintendent.

The results accomplished by this system are two-fold. In the first place, only that work which is necessary on the engine is done and no time is wasted in taking down and replacing parts which are in good condition. In the second place, new material is not used unless it is necessary, and greater care is taken of the material which is stripped. Under former conditions a considerable amount of material was lost, misplaced, or stolen for use on other engines, and often new material was ordered when the old material could have been used to good advantage.

The inspector watches the progress of the work on the engine while in the shop. When it leaves the shop it is placed in charge of an engineer, whose duty it is to break in engines and give them a trial run. The engineer reports all defects, and the various gangs whose work has proved defective are given a certain amount of time to place it in good condition, after which time the engine is again carefully inspected by the shop inspector. If the work specified has not been done, a deduction is made from the bonus of the gang foreman, depending upon the amount of time which the engine is delayed. The other members of the gang, of course, lose, in that while they are doing this work in the roundhouse they are not keeping up with their regular work in the shop and will therefore lose proportionately upon their bonus for the next engine.

Estimating Locomotive Repair Costs.

As soon as the inspector has made his detailed report as to the work which is to be done upon an engine, a copy of it is given to the material supervisor and he at once proceeds to estimate the labor cost. When this feature was first started, the estimates were not very accurate, but after a number of engines of various classes had passed through the shop and detailed data was obtained as to the average time required for different operations, it was found possible to make fairly close estimates. Often it is found that additional work, not specified by the inspector, becomes necessary, and in such instances, after it has been authorized by the shop superintendent, the estimate is revised. A sample of one of these estimates, except that the third column has been added, which shows the actual labor cost of the work done on the engine, is shown in the next column.

The first estimate of $800 was increased to $873, due to additional work which was authorized, and it will be noticed that the actual cost was within $30.67, or 3.6 per cent., of the estimate. As soon as possible after an engine leaves the shop the actual cost for each gang is compared with the estimated cost. An estimate of this kind is useful in several ways; each gang knows that its work is being closely watched, and thus, in addition to earning their bonus, they have an incentive to keep down the cost. It also enables the shop superintendent and his assistants to keep in close touch with the work and detect any irregularities or weak spots and take measures to correct them.

Estimated and actual labor cost for engine No. 1000. Assigned to Aigner for heavy repairs.

Gang.	Estimated.	Authorized.	Actual.
*1	$54		$62.16
2	7		16.07
**3 or 4	95	$150	151.06
5	27		25.30
6	3		
7	21		18.67
9	25		20.10
10	1		.68
11	5		5.96
12	20		18.76
14	23		14.60
15	4		8.64
16	11		11.53
17	16		13.91
18	35	39	41.99
19	15		14.60
20	22	30	33.00
21	26		27.45
22	23		19.32
23	5		9.47
24	12		17.35
25	0		
30	89		95.46
31	21		12.27
35	3		4.50
40	64		66.31
41	9		16.64
43			.18
47			1.89
50			.78
52	10		5.88
56			.51
70	21	15	12.63
Supv. Bonus, etc	133	145	156.00
Totals	$800	$873	$903.67

*Includes gang No. 13.
**Includes gangs 27 and 29.

Locomotive Repair Schedules.

An important feature in connection with the improvement of the output at the Topeka shops is the locomotive repair schedules. On page 338 of our September issue Mr. C. J. Morrison described these schedules and copies of the erecting floor schedules for light, heavy and general repairs were reproduced. In addition to these schedules, each gang has similar special schedules for their own work, and by means of the cardboard strips showing the working days in each month and the date upon which the engines entered the shop it is possible for them to determine immediately the time at which any part of their work is expected to be completed for a given engine.

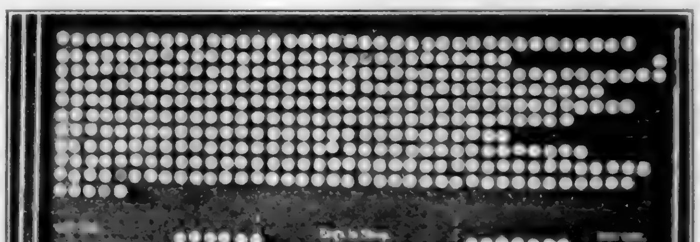


FIG. 42.—SHOP CONDITION BOARD IN SHOP SUPERINTENDENT'S OFFICE.

The subject was thoroughly treated by Mr. Morrison in the article cited above.

To keep the shop superintendent, the storekeeper and the betterment department informed as to the engines in the shop

By looking at the dispatching boards the foreman, knowing what work is to be hurried or is of the greatest importance, [illegible] machines. The slip at the head of the column, immediately under the machine number, indicates the piece of work in the machine. Shortly before this work is finished, the machine operator advises one of the timekeepers, or the foreman, and [illegible] tructions as to the next piece of work. By means of a messenger (two boys are employed), the order for the next job is sent to the machine operator in sufficient time, so that he [illegible] material.

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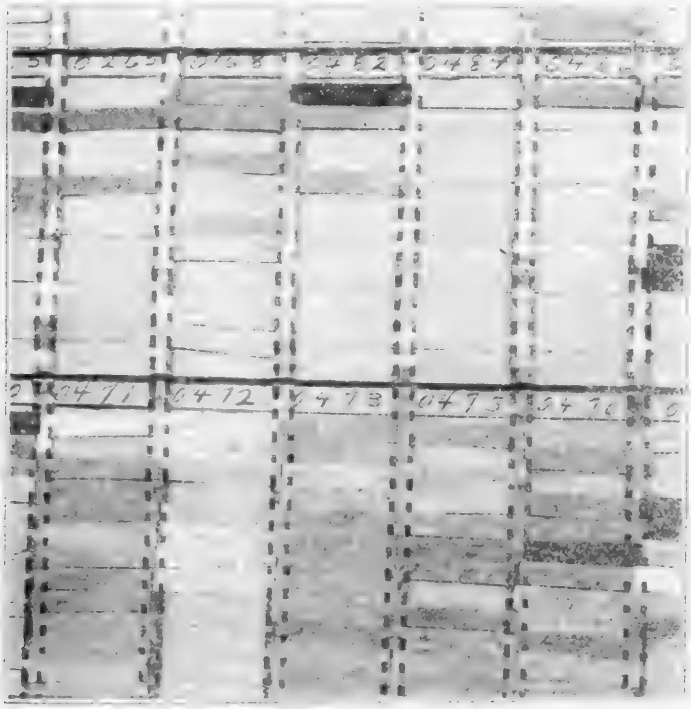

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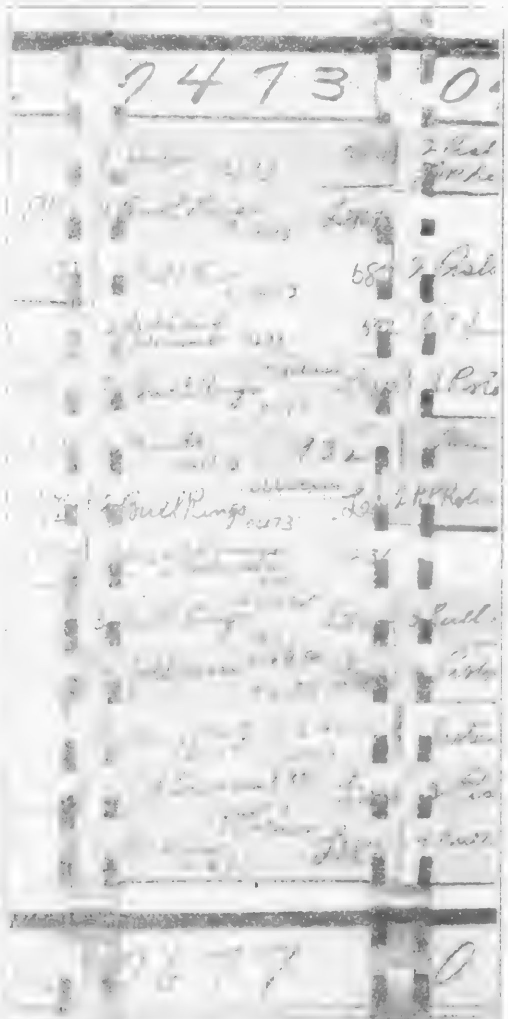

[illegible] DETAIL OF DISPATCHING BOARD.

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Locomotive Repair Schedules.

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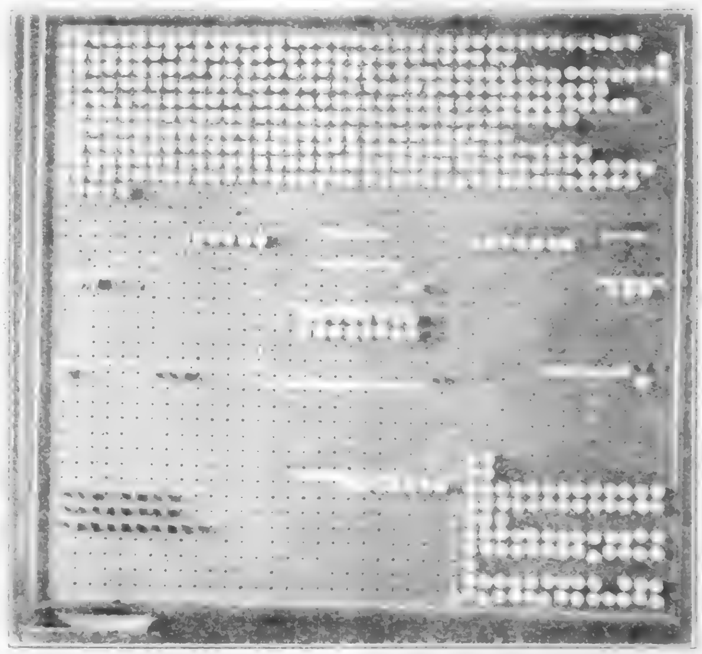

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The subject was thoroughly trea[illegible] Mr. M[illegible] in the article cited above.

To keep the shop superintende[illegible]

and their condition, two kinds of diagrams or condition boards are used.

The photograph, Fig. 42, shows the board in the office of Mr. Purcell, the shop superintendent. Upon the round white discs, which are fitted with pegs, is shown the number of the engine, the date it was placed on the hospital track, the date it entered the shop, the name of the erecting foreman who has it in charge, and space is left for the date when the engine leaves the shop. The first row at the top shows the engines turned out during the month of January; the second during February; the third during March, etc. The engines are placed in these rows in the order in which they are turned out of the shop, beginning at the left. A white disc is also inserted for each Sunday or holiday as it occurs.

A somewhat different arrangement is kept in the offices of the counselling engineer and the general storekeeper. These may best be explained by the use of the diagram shown in Fig. 43. The figures at the top of the diagram show the number of days that the engines have been in the shop. The black spots on the diagram represent small blocks upon which the engine number is printed. The faces of these blocks are of different colors; for instance, a white block signifies that an engine has been wheeled; a yellow block that the engine is going through the shop on schedule and a red block that the engine is held for material.

The diagram shown in Fig. 43 shows the condition on March 30, 1906; and Fig. 44 shows the condition for the same date one year earlier. Comparison of these diagrams will

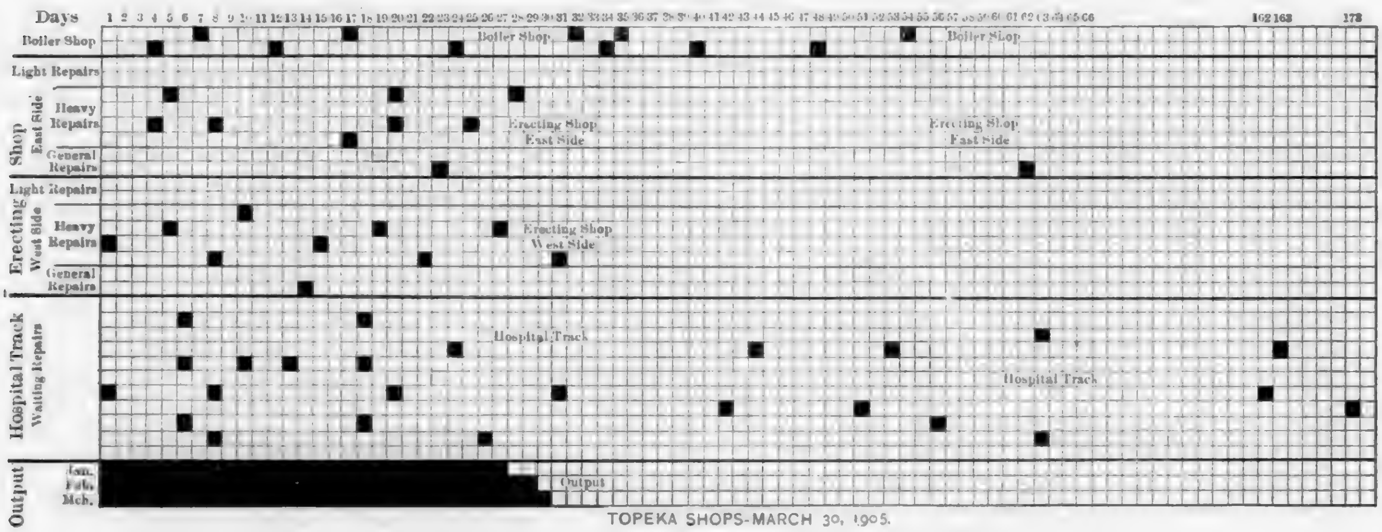


FIG. 44.—CONDITION OF TOPEKA SHOPS, MARCH 30, 1905.

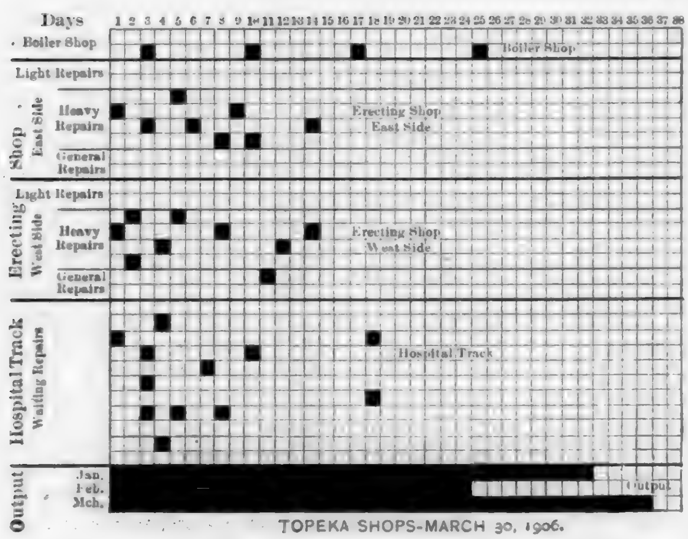


FIG. 43.—CONDITION OF TOPEKA SHOPS, MARCH 30, 1906.

At the end of the year a record is made of the upper part of this board and the pegs are removed.

Below this, on the left side of the board, is shown the engines on the west side of the shop. As soon as an engine is wheeled it is placed in the proper place on the board. When an engine leaves the shop it is placed lower down on the board under the heading "Engines out, week ending." At the end of the week these pegs are transferred to their proper place at the upper part of the board. The left-hand side of the board shows the condition for the east side of the shop, the white pegs at the lower right-hand corner being extra ones. In the centre of the board are shown the engines in the boiler shop; the engines on the hospital track; the engines to be shopped during the week and the engines that are held up for material. A few moments' study of this board shows the shop superintendent whether the work is being handled satisfactorily or not.

show exactly what had been accomplished during the year in the way of shortening the time the engines were held in the shop and on the hospital tracks.

At the present time practically no light repairs are being made at Topeka, but the heavier repairs for the entire system are handled at that point. As stated in Mr. Morrison's article on "The Locomotive Repair Schedule," fourteen days are allowed for heavy and twenty-five for general repairs. The actual boards have sufficient space to show the output for one year.

Application of the Individual Effort Method to Roundhouse Work.

Mr. J. F. Whiteford has had entire charge of roundhouse betterment work.

In applying the individual effort method to roundhouse work a time study was first made of the different operations concerned in wiping or hostlering different classes of locomotives. The following table, for instance, shows the number of units or cents which it was determined, as a result of this time study, would be a fair compensation for the different items.

Table of Units.	Coaled and Watered.	Wooded.	Sanded.	Fires Knocked.	Fires Cleaned.	Boilers Washed.	Boilers B. O.	Water Changed.	Flues Bored.	Wiped Freight.	Wiped Passenger.	Splr. Hdld.	Front End.	Fires Built.	Turn Table.
01—0300.															
138—255..															
260—399..	7	2	5	18	12	65	5	30	12	25	45	8	10	8	3
1—137..															
2155—2418.															
400—502..															
564—788..															
2000—2034.	7	2	5	24	12	70	5	30	12	30	50	8	10	10	3
2100—2154.															

The total of each class of operations performed on each engine handled is multiplied by the cost as determined above, which total for all the engines handled will give the unit allowance for each roundhouse. The unit allowance for additional expenses is fixed arbitrarily at 30 per cent. of the

unit allowance of direct expense, except for points where there is no general expense charged. Comparing the expenses, based on such a time study, with the actual cost for wiping and hostlering gives the efficiency of this part of the roundhouse work.

All the operations in roundhouse work have been scheduled and given a standard time allowance. Comparing the actual time for all work with the standard time, the efficiency of a roundhouse may readily be obtained, and reports of this kind are actually being made each week for certain points where the work is being introduced. Following are a few items taken at random from the roundhouse schedule:

Subject.	Schedule No...	Description of Work.	No. of Men	Classes.	Time
Wiping	0074	Wiping tank frame and truck complete	1	All	0.4
Wiping	0068	Wiping machinery below running board inside of frames, including engine trucks, eccentrics, blades, straps, motion work and axles, inside surface of frames, rocker boxes, cylinders, saddles, brake rigging, also guides, rods and crossheads of balanced compound engines, lower part of jackets and all parts between frames not specified	1	ABCD FU ST	0.6 1.0 0.8
Air Work Governor	013[illegible]	Overhauling air pump governor complete	1	All	0.5
Rocker Boxes	1244	Tightening rocker boxes	1	All	0.3

If a man reaches the standard time as indicated in the schedule he is entitled to a 20 per cent. bonus; if a longer or shorter time is required the bonus is governed by the bonus curve, Fig. 34.

The following figures cover only the wiping and holstering, and are for the A., T. & S. F. Proper. In January, 1906, 24,627 engines were handled at a total cost of $57,858.32, as against 25,849 engines handled in September of the same year at a cost of $47,263.01, or, in other words, 4.9 per cent. more engines were handled, at a cost of 18 per cent. less, in September than in January. The work in this department, however, has only been in effect a short time, and a fair comparison cannot be made until results are obtained extending over a greater period of time, and averaged to eliminate varying conditions. Judging from the results gained at one or two roundhouses which have been given special attention, the final results in improved efficiency and economy will be in line whith those already attained in other departments.

Application of the Individual Effort Method to the Car Department.

This work, under Mr. J. Epler, has only recently been placed in operation, and is conducted along somewhat similar lines to that of the roundhouse work. A schedule has been carefully drawn up for each operation in repairing cars, a standard time being designated for doing each piece of work. The amount of bonus paid is regulated according to the bonus curve, Fig. 34.

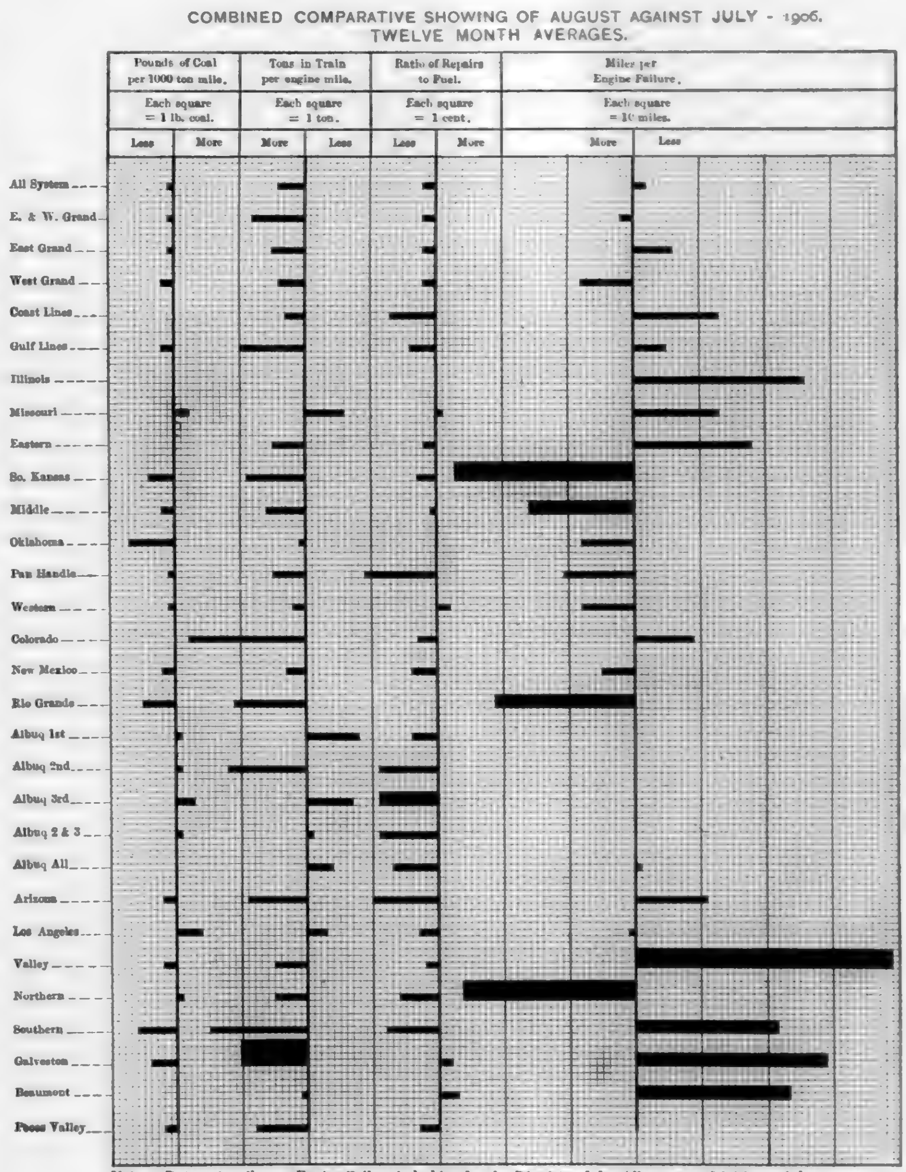
An improvement recently introduced at two of the car-repair points is to have the inspector carefully look over each car, see just what work is to be done and then refer to his schedule to determine the standard time in which the work should be completed, based upon the standard time for the various operations. The car is then turned over to the gang, and the bonus earned is divided among the members of the gang in proportion to their rate of wage.

Engine Equipments.

The matter of systematically looking after the engine equipments is an important one. The efficiency of the locomotive in service depends upon having these equipments in proper condition and very often a considerable amount of time is lost, due to some important tool or device not being on the engine when it is needed. There is also little question but what these engine equipments are a much greater expense to the company than they would be if systematically looked after, and in spite of this increased expense they are usually incomplete. Under the direction of the betterment department the Santa Fe has recently undertaken to systematically look after these equipments somewhat along the lines of the method in use upon the New York, New Haven & Hartford Railroad, which was described by Mr. Raffe Emerson, who is now under Mr. Jacobs and in charge of this work, on page 412 of our November, 1905, issue.

Power Plants.

Mr. C. B. Goode of the betterment force has had charge of improving the efficiency of the power plants. This work has consisted largely in reducing to a minimum the losses of steam due to leaks and radiation and to stopping leaks and correcting abuses in the use of compressed air. In several instances by improving the conditions, equipment which appeared to have insufficient capacity has been found to be entirely satisfactory and new equipment did not have to be ordered.



Note.— Data as to miles per Engine Failure is lacking for the Districts of the Albuquerque Division and the Pecos Valley Lines. Otherwise the absence of blocks indicates no change from record for preceding twelve month period.

FIG. 45.—COMPARATIVE ENGINE PERFORMANCE DIAGRAM.

Engine Performances.

A considerable improvement has been made as concerns fuel consumption, tonnage per train and engine failures. This has been done by forcibly directing the attention of the mechanical superintendents, master mechanics and road foremen of engines to the actual conditions and tendencies by means of diagrams similar to those shown in Figs. 2 and 3.

In addition to these diagrams showing the engine performances a comparative diagram is made each month based on twelve-month averages and showing the standing of each

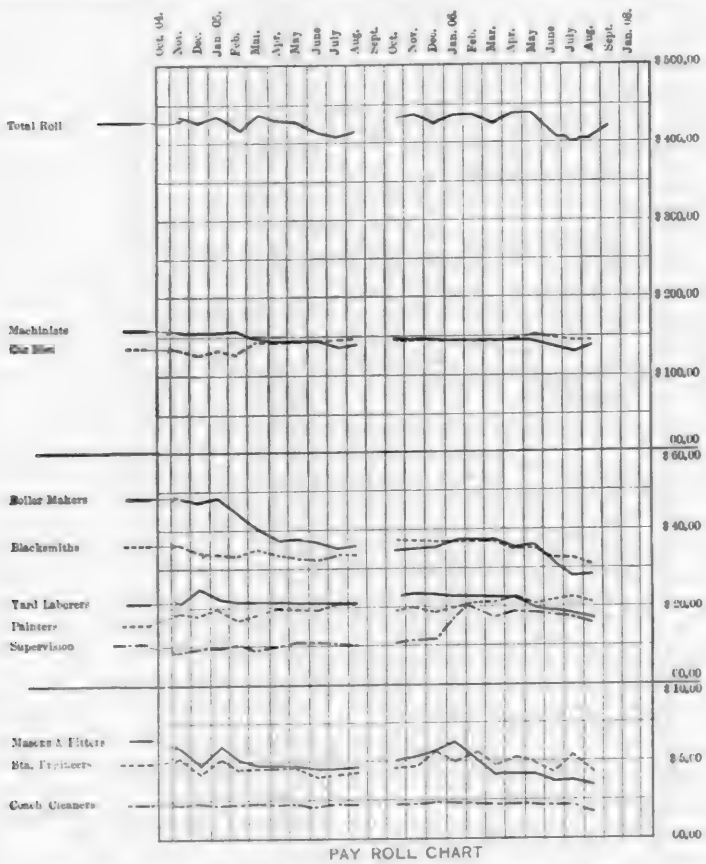


FIG. 46.—HOURLY PAY-ROLL CHART FOR TOPEKA SHOPS.

division as compared to its previous month's record. One of these diagrams is reproduced in Fig. 45.

In addition to these measures a member of the betterment force, Mr. T. W. Neely, who is a specialst on fuel oil burning, has for several months been at work on the Gulf Lines, introducing improved methods of oil burning, and gratifying results have been obtained. At the present time he is introducing his methods upon the Coast Lines, where the greatest amount of fuel oil is used on the system.

Graphical Check of Payrolls.

It is difficult to intelligently improve conditions if the figures concerning the operation of a department are not received until weeks later. One of the aims of the bettermend department has been to have such figures available as quickly as possible and to furnish them to the mechanical superintendent, master mechanic, or shop superintendent, not only promptly but in such a form that they may readily be digested.

As an illustration, Figs. 46 and 47 show the payroll distribution of two shops. The one at Topeka is uniform and orderly, the other is confused and indicates a lack of system. These payroll records are based on the rate per hour to eliminate the variation between long and short months. At present all over the system the master mechanics are being furnished daily with the amount and distribution of their payrolls in order to check against the ideal figures. Also graphs of twelve-month averages are being furnished of grand division payrolls in proportion to train tonnage handled. This relation will show whether one division is relatively higher than another, or whether compared to traffic, shop expenses are going up or down.

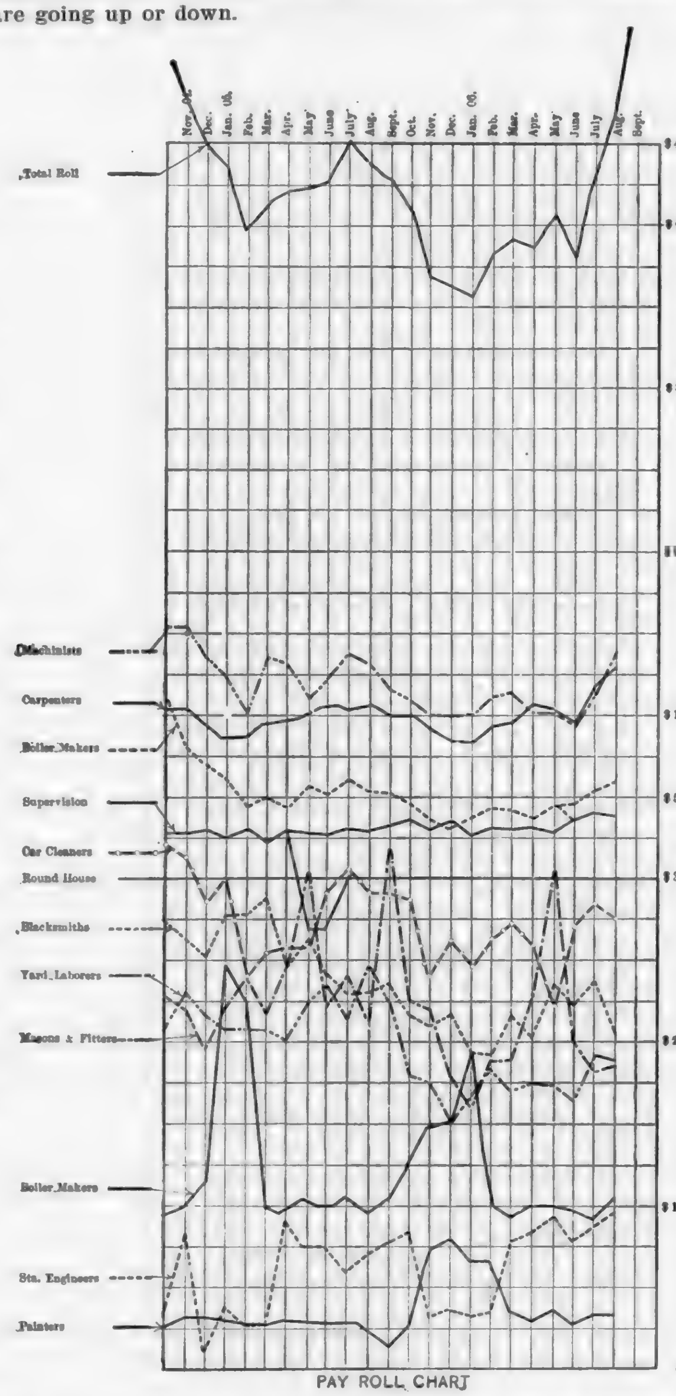


FIG. 47.—HOURLY PAY-ROLL CHART OF SHOP IN WHICH BETTERMENT METHODS HAVE NOT BEEN INTRODUCED.

Summary.

Betterment work means the highest efficiency at the right time and place at the lowest cost. Economy is never the aim sought for, but results indirectly and in fullest measure from the same methods which secure efficiency.

Betterment work affects beneficially every one connected with railroad work from the wage earner to the shareholder.

Usually the shareholder expects and demands certain results which through a long series of dilutions finally affect, and often unfavorably, the worker; hence reductions of force, reduction of pay and resulting enmity and strikes. The newer methods begin at the bottom, with the elementary operations, benefiting each man and as these are perfected efficiency grows from item to part, from part to whole, from whole to operation and with efficiency in, economy beginning in fractions of a cent saved on a minutes time swells through all the number of all the employes, benefitting each employe as it covers his work until in the end it swells into a mighty sum aggregating millions of dollars.

Effect of Betterment on the Workmen, Officials, and Owners.

(1.) To the competent and reliable workman it brings the square deal, recognition of his individual ability and skill, increased pay, greater security of position.

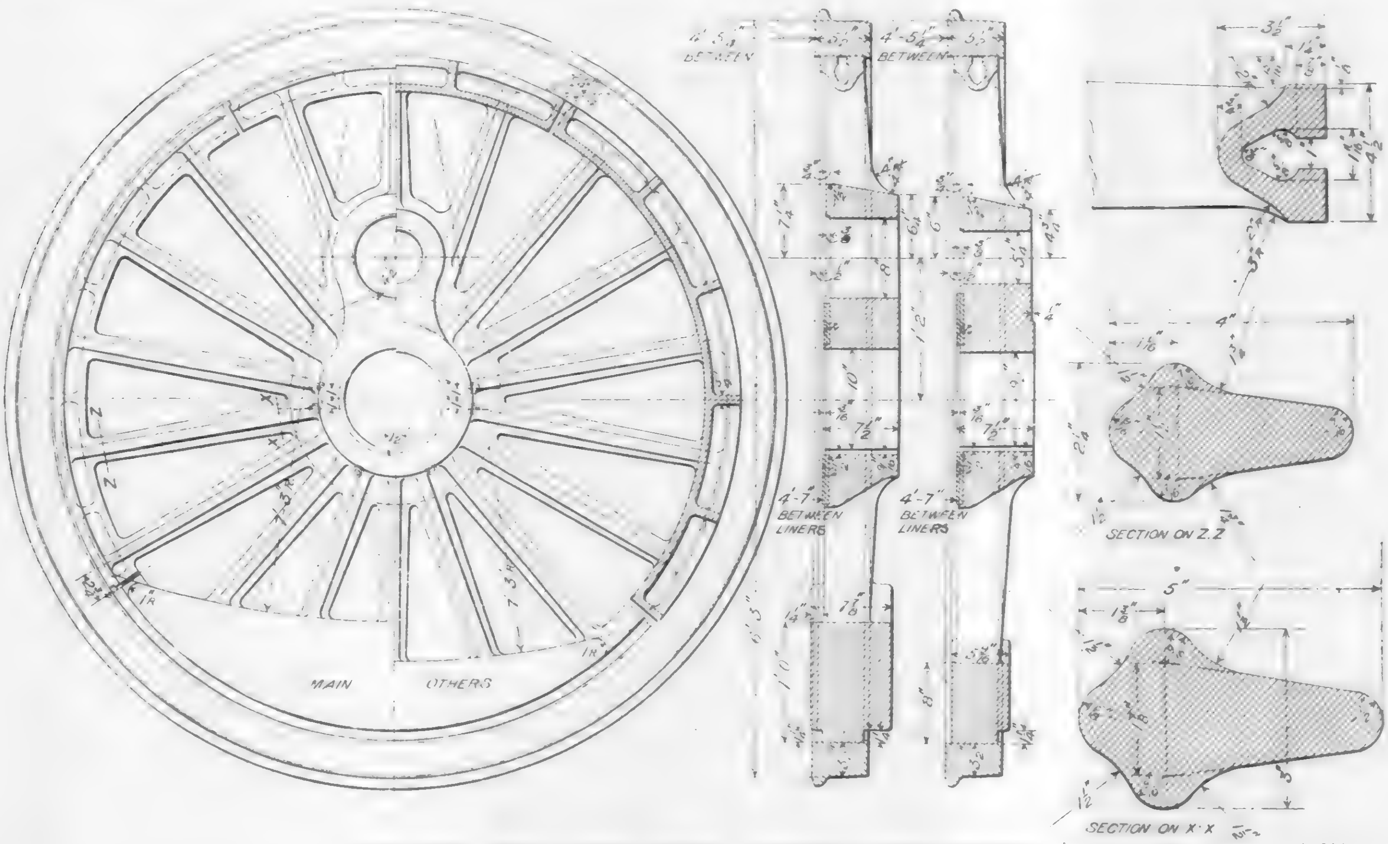
(2.) Of the foreman, no longer slave driver, it makes a planner, an inspector, an administrator, thus developing him and fitting him for a higher position and responsibilities, and the better he plans the higher his pay, not as a favor for which he must forever be subserviently grateful, but as a natural right due not to his personality but to his performance.

(3.) To the superintendent of shops or master mechanic it gives a body of loyal and efficient employes who are constantly helping, instead of hindering, and he is thus freed from time and energy absorbing detail. It gives him the facts on which to judge without personal bias or feeling, of the efficiency of every man, foreman, machine or operation.

(4.) To the higher official it will show in a single figure the efficiency of a shop in any given month, or at a glance show the efficiencies of any division as to all its important operations. It determines the relative economy of one engine type as against another. It is safe to say that with properly collated records in graphical form, each based on long intervals, the high official can in one hour a month ascertain better what is going on than he could formerly in days of surmise and uncertainty.

(5.) By means of the records boards of directors can intelligently approve of recommendations, and when a choice is forced act on what is essentially of greatest importance, the most important betterment rarely being the most obvious.

(6.) Finally shareholders as well as workers will benefit, the latter through their more intelligent and less wasteful efforts, the former through the aggregated and harmonized efficiencies and resultant economies of all operations.



CAST STEEL DRIVING WHEEL CENTER.—CANADIAN PACIFIC RAILWAY.

CAST STEEL DRIVING WHEEL CENTERS.

CANADIAN PACIFIC RAILWAY.

In connection with preparing the designs for Classes G1 and G2 Pacific type locomotives on the Canadian Pacific Railway, which designs were undertaken at the same time that standard parts were being adopted for these and other locomotives,* a 68-in. cast steel driving wheel center was designed, which contains a number of interesting features. While this design differs in some points from the recommendations of the committee on "tire shrinkage and the design of wheel centers," whose report was made at the last meeting of the American Railway Master Mechanics' Association, still it is in accordance with those recommendations in its main features.

It has 18 spokes, where the recommendations called for but 17, and has four shrinkage slots, which are fitted with cast iron filling blocks. In other respects, such as area of spokes at rim and hub, distance between inside faces of hubs, straight spokes, bearing area for tire, etc., it is in accordance with those recommendations. The shape of the spoke carries out the recommendations of the committee even further than the design shown in their report, and places a very large proportion of the metal directly below the tread of the tire, where it is of the most value, and, at the same time, the width of the spoke is made large enough to give the necessary stiffness. The rim is made in a hollow U-shape, which, while it gives sufficient bearing area, has its metal so placed as to give a better support to the tire between the spokes than if it was cast solid.

*See American Engineer and Railroad Journal, 1906, pp. 126, 161, 212 and 388.

Text Books Needed.—The instructors at the Winona Technical Institute, Indianapolis, Ind., find themselves handicapped for want of text books on the different trades being taught there. They say that the field of text book literature for trade schools is practically untouched and that such books should be written by men who have had practical training for long terms in shop service.—*Iron Age.*

(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE.

J. S. BONSALL,
Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT, E. A. AVERILL, } Editors.

DECEMBER, 1906.

Subscription.—$2.00 *a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

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We owe our readers an explanation as to the delay in issuing this number. For the past two years or more we have been watching the progress of the betterment work on the Santa Fe System. The officials, however, did not feel that it would be wise to publish an account of this work until it had been given a sufficient trial to demonstrate clearly the results to be obtained. Mr. Kendrick and Mr. Lovell very kindly gave us permission to visit Topeka the early part of November and make a thorough study of what had been done. The results of our investigation were such that we felt that the matter was of too great importance to present serially, as is our usual custom with articles of any considerable length, or even to hold it for our January issue, and we have, therefore, taken the liberty of delaying the present issue in order to present the matter in a complete form at the earliest posible moment. The fact that so much space is devoted to one article in one issue is justified by its importance and the fact that it touches intimately on practically every interest in the mechanical department.

The growth of the different roads during the past few years and the combination of smaller roads into large systems has been so rapid that it is not surprising to find that matters of efficiency and economy have oft-times been overlooked. The time has come, however, when these matters must be investigated carefully. The situation on the Santa Fe in 1904, due to the labor troubles, was a serious one, and great credit is due to Mr. J. W. Kendrick, second vice-president, for taking such radical and successful measures for solving the difficulty and for improving the efficiency of the mechanical department. It is true that other roads have realized the need of betterment work, and in some instances have made considerable progress, but nowhere do we find such radical treatment or such striking results as on the Santa Fe. Whether the exact treatment used on the Santa Fe would give equally good results on other systems may be questioned, but there can be no question but what the general principles used by Mr. Emerson in his work on the Santa Fe are equally well suited for conditions on other railroads in either the motive power or other departments.

THE SURCHARGE PROBLEM.*

TO THE EDITOR:

Have read the comments on the Surcharge Problem in your issue for November, 1906, with great interest.

Mr. Theo. F. H. Zealand voices a very obvious yet untenable objection. It is true that if a shop contains two machines whose output has to carry all the expenses, and if one of them is shut down the other will have to carry double load. When, however, railroad shops all over the country are expanding, adding to their equipment, and installing new machines the objection does not apply. One of two courses is necessary, either to add to present equipment and proportionately bring up the surcharge, or to buy on the outside those articles which are not economically manufactured in a railroad shop.

It is also easy to fall into the error of confounding surcharge with cost. If a shop has ten men and a surcharge of 80 per cent. on their wages, and can manage to do the same work with five men and a surcharge of 160 per cent. on their wages, the output is cheapened in spite of increased surcharge.

"Shop Superintendent" is also filled with skepticism. The facts are:

(1). That it takes some little time to determine the proper machine rates and surcharges to each department, although at a pinch they could be done with all needful accuracy in a fairly large shop in a very few days.

(2). That after this initial work is once done it takes neither clerical force nor any appreciable time to determine the actual cost of any single article.

(3). That cost need have no connection with accounting. A railroad may give away its manufactured material if it so elects, or it may sell it for twice its cost if it can find a customer, neither of these actions having any bearing on the question of cost determination which remains the same whether any accounts are kept, or articles are given away or sold for high profit.

(4). Finally it is possible in a shop turning out 360 locomotives, to determine with extreme accuracy and *in advance* the cost of every operation, or collection of operations and this with very little clerical force. In the shop in which Mr. Morrison holds an important position, the cost of repairing each locomotive is determined largely through his work, before any work is begun and on an average within 3 per cent. of accuracy.

H. EMERSON.

Topeka, Kan.

* [For information concerning the application of surcharges at the Topeka shops see page 469.]

To the Editor:

The interesting article on the Surcharge Problem, by Mr. C. J. Morrison, and the editorial regarding it in your October journal, also the letters on the same subject in the November journal, are of great interest to all persons interested in economical shop management, as it is only by becoming acquainted with the cost of doing work that the best results may be obtained, and while everyone may not be able to carry out this matter to the extent advocated, still, if given proper attention, it will result in a saving of money for our employers.

As stated by Mr. Morrison, more attention will be given to requests for new high-power machinery, when the person requesting it is able to demonstrate the resulting economy, and it will also frequently deter the asking when the actual saving to be obtained is figured up in dollars and cents.

Another result is that, if this surcharge is followed up closely, and especially by machine foremen, it will result in the keeping of each machine in constant use and the dispensing with machines that are unnecessary and seldom used.

I do not agree with Mr. Morrison that in all cases it is cheaper to buy, when the cost of manufacturing in railroad shops is greater than the market price. It is frequently necessary to manufacture material as a filler in order to keep men and machines busy, and the cost of this work, owing to the number of times it has to be laid aside, is apt to make the price excessive; yet, at the same time, it is economical for the company to do it, and the reasons for the price being high should be given due consideration.

Shop surcharge and cost of manufacturing can be materially reduced by properly locating the point of manufacture, which, in most cases, should be at main shops. When it is not expedient to do all of it there, the outside shops should each have their special line, so as to save unnecessary duplicating of expensive machinery, and also to give opportunity for the use of jigs and special appliances which would not be economical when only limited quantities are made. The proper grouping and locating of machines, to avoid unnecessary handling, will also be found to be a very important factor in cheap production.

The difficulty of getting accurate costs of manufactured material in railroad shops is admitted by all. In most cases, it is not entirely the fault of the accounting department, but is frequently due to the improper charging of time by workmen. This is especially true where the same men do repair work.

I fully agree with Mr. Morrison regarding the advisability of sometimes raising the wage rate in order to increase the output, but in most cases this is impossible, owing to agreements with labor organizations, as the minimum rate is also the maximum.

It seems that, with sufficient thought regarding cost and surcharge and proper supervision, there should be no reason why the larger part of the material entering into construction and repairs cannot be manufactured in railroad shops in competition with outside firms when used in sufficient quantities to enable economical manufacture.

Mr. Morrison's statement that too much stress is put on the pay-roll may be true, but if this was not so it would likely lead to extravagance, and it is doubtful if the time will come when this will not receive the first consideration by officials, and I do not see how, when reductions have to be made, it could be done on the amount of surcharge, as this is comparatively a fixed charge when once established.

CHARLES COLEMAN,
WINONA, Minn. *General Foreman C. & N. W. Ry.*

TO THE EDITOR:

On page 438 of the November issue appear several communications on "The Surcharge Problem," which show that considerable thought is being given to the subject. It is a very complicated subject and one that can hardly be grasped in a single reading. Perhaps weeks of preliminary work will have to be done before the surcharge can be figured for a simple shop.

Mr. Zealand's point of view of closing one department, and doing no other work is a phase I did not consider because of the fact that at present nearly every shop in the country is crowded with work, and as soon as they cease to manufacture one article they start in on another. However the idea of closing the plant is worth considering. Suppose we consider an extreme case and close an entire plant, but do not dispose of any of the equipment. Class 1 (page 376, October issue) would be effected only in D. which would be reduced to a very small figure, and Class 1, would probably be 6.5 per cent. Of Class 2, the watchman only would remain. Of Class 3, A would drop to 2 per cent., 2—B would remain unchanged, while the other items would become zero. Of Class 4—A, B and D are unchanged, while C becomes 4 per cent., and the other items zero. Our total surcharge on a fully equipped plant standing idle is, therefore, expressed as a percentage of the former pay-roll:

1.	Rent.	
	A	1.8
	B	1.8
	C	.6
	D	.3
	E	.6
	F	1.4
2.	Supervisory and Miscellaneous.	
	A-B-C-D	.0
	E	.4
3.	Machinery.	
	A	2.0
	B	1.5
	C-D-E-F-G	.0
4.	Power.	
	A	.2
	B	.2
	C	.4
	D	.2
	E-F-G-H-I	.0
	Total	11.4

The surcharge of 11.4 per cent. of the former pay-roll would, of course, still have to be cared for and would be added to the cost of the purchased articles.

Mr. Zealand misses the point when he states that the surcharge would not be effected by the manufacture or discontinuance of manufacture of a given article. The surcharges are there and must be taken care of. The surest way to reduce the surcharge on any particular item is to produce more of that article in a given time.

Another way to reduce the surcharge percentage is to work 720 shifts per year instead of 300. In fact the surcharge would make certain plants unprofitable if they were unable to work nights as well as days.

In many instances a careful study of the surcharge will show certain items to be abnormally high. These items can then be given attention and reduced. I have in mind a case where a reduction of 2-D (Spoiled Work), page 376, October issue, saved a firm from going to the wall. In another case moving certain portions of the work, made a large reduction in 1-E (Insurance).

In answer to "Shop Superintendent" I would state that a railroad repair shop handling 360 engines a year and manufacturing for a large system installed the system as outlined without the addition of a single man to the force. Whenever questions of new machinery, of purchasing articles, of making new parts instead of repairing old, of manufacturing at other points on the system instead of at this point, etc., come up the surcharges are carefully studied. A card is kept for each machine, as shown above and the machine foremen know the rates of the machines as well as the rates of the men, and assign work not only with the idea of the man's rate but also of the machine's.

PRESENT NUMBER
CLASS
NUMBER
LOCATION
MAKE
HORSE POWER
AGE
VALUE
DETERIORATION
HOUR RATE
PER CENT USED
SHOP RATE

This prevents high-priced machines from being loaded with work that could be done just as quickly on an old low-priced machine, and at the same time prevents the low-priced machines being assigned work that they are not capable of doing as cheaply as the higher priced machines on account of the longer time consumed.

The first step in installing the above system was to determine the surcharge for the plant as a whole, as outlined on page 376 of the October issue. The original cost of the buildings and machinery was obtained and the value at the present time was estimated, then the rates of interest and depreciation were assumed. Other items were for the most part obtained from the accounts, but not without considerable work, and in a few cases it was necessary to estimate them.

The second step was to divide the charges between the locomotive and car departments.

The third step was to distribute the charges among the different departments; for instance, let us consider the locomotive de-

partment. Each shop, such as pattern, forge, tin, machine, etc., has a specific surcharge. Item 1, rent, was apportioned according to the building and ground occupied. Item 2A (supervision and office), was apportioned largely by estimate, as just how much time the superintendent of motive power, mechanical engineer and others of the higher officials give to each department is unknown; B (accounting) was apportioned in proportion to the number of men; C (drawing room) according to the new drawings used by each department per month; D (spoiled work) was at first estimated, but was afterwards determined exactly; E (laborers) according to the work done for each department, and watchmen, according to the space covered. At first 3 A, B, C, D (machinery—depreciation, interest and repairs) were distributed according to the valuation of the machines, and E, F, G (replacing small tools, tool steel and supplies) were estimated for each department, but afterwards the accounts were kept so that these charges for each department were known.

A recording ammeter was placed for a week at a time on the different motors, and the cost of the power actually used was charged. Heat was apportioned according to the building occupied; light according to the number of lights and the hours which they burned; the water used was estimated. The air compressors were carded and the air used by each department measured. The hydraulic pump engines were also carded.

This gives the total surcharge for any one department. The next step is to divide the charge between the men and the machines. Item 1 (rent) was arbitrarily apportioned, half to the men and half to the machines. Of item 2 (supervising and miscellaneous) the machines get a very small percentage, probably 10 per cent. of each charge, except D (laborers and watchmen), all of which goes to the men. Item 3 (machinery), except G and E (supplies and replacing small tools), is divided between the men and the machines in proportion to the value of the machines to tools and machines used solely by the men, such as elevators, air hammers, cranes, etc. In the crane charge an exception is made in the case of cranes which serve only one machine and are virtually a part of that machine, in which case they are charged against the machine. E (replacing small tools) is carried entirely by the men, and G (supplies) by the machines.

Item 4 (power, heat, light, water, etc.) is apportioned according to the power used to run the machines and the power used for the convenience of the men. Light and heat are charged entirely to the men, while water is charged partly to the machines.

We now have the charges divided against the men and the machines. The surcharge on the men in any department is applied as a percentage of the payroll, while the surcharge on the machines is applied as an hourly rate. At first the machines were charged in proportion to their valuation, and the number of hours run per year were estimated. Later, when the accounting the actual power it used, paid for its belts, etc. Of course, made it possible, each machine was charged according to its actual expenses. Thus a machine paid rent for its shop room, paid for in the case of machines in groups it was necessary to estimate the power used by any one machine. The accounts also show the hours which each machine runs. Thus the surcharges are brought down to figures as nearly exact as any charge of this nature can ever be.

Of course, some one else may divide the charges differently between the men and the machines, or between the different departments. Some of the divisions are largely a matter of judgment, and would, of course, be different in different shops. The real point is to be able to determine exactly how much any particular article costs. The exact method of determining this cost is immaterial as long as the result is accurate.

It is true, as "Shop Superintendent" states, that the accounts on many railroads are kept in such a way that some of the items comprising the surcharges would be difficult to obtain, and some of the items may have to be estimated the first time. However the surcharges must be revised from time to time, and the method of accounting can easily be altered to give the necessary information. For example, in the shop with which I am connected, repairs to machinery, which were formerly charged to a general account, are now charged to the individual machines by number. Hand tools are no longer charged to a general account, but to the department using them. A recording ammeter, placed for a week at a time on the different motors gave the current consumed by each. Thus we find ourselves able to tell the exact surcharge on any machine or any department without estimates entering into the calculation. The only opportunity of error is that during 1907 we will make the shop earn the 1906 expenses. In case the 1907 expenses go higher than the 1906 we are to the bad, but in case they run lower we have just that much on the profit side to use for improvements or new machinery. With careful management only some very unusual circumstance will cause the expenses to change enough to seriously affect the surcharges.

I wish to ask a question which may show the value of the surcharge study. A large number of railroads are building locomotives. How many of these roads know, not guess but know, whether they are building these locomotives at a profit or a loss?

C. J. Morrison.

Topeka, Kan.

THE DRAFT GEAR SITUATION.

To the Editor:

I have read with a great deal of interest the communication signed "A Rail Roader," published in your November, 1906, issue on the subject of the draft gear situation, and while I am an ex-railroader, and not identified with the business at this time, I am going to make a suggestion or two that possibly may answer some of the questions asked by your correspondent.

The inquiry of a railroader, "If the friction gear has so many advantages, why is it that it is not more generally used," might be answered by him and every other railroad man if introspection was used instead of inquiry. The interesting fact is that by instinct and education all railroads object to changes in their present practices, or improvements in their general equipment. This was true in regard to the air brake, the vertical plane coupler, and everything else that has been brought out for the improvement of railroad practice in the last quarter of a century. Nothing new is ever presented to a railroad, however meritorious it may be, that is not condemned at once, and is only placed in service after a long and expensive fight by the manufacturers, often resulting in bankruptcy of the inventor and the manufacturer before the device is recognized. It is not necessary to particularize this statement, as every railroad man and manufacturer can conjure up from his memory many cases that fit this statement.

There are also many railroad men in the United States that are opposed to everything that has been invented that is contrary to the practice of the railroad when they went into the service. One manufacturer of a draft gear told me a short time ago that in conversation with a Master Car Builder of one of our principal lines, who had been in service almost if not quite a half century, the subject of service strains was brought up, and to the statement of the manufacturer that the ordinary spring gear was recognized now as inadequate to the demands, the Master Car Builder replied that that could not be true. The manufacturer says that he brought up the dynamometer car test in support of his statement, but this was brushed aside by the Master Car Builder with the statement that he had been in the car business a long number of years, and therefore, he certainly knew. There are a great many railroad men who take this position; that is, that their long years of service in the car business makes them a better judge of the requirements of railroads and railway cars than any test that could be made by improved indicating machinery.

Another case related to me by a manufacturer of draft gear had to do with another very prominent railway system, where the device had been solicited for a laboratory test, and was sent of course. After several months the device was returned to the manufacturer with a statement that the *test developed the fact that it could not be used on this particular railroad on account of the cost.* It developed afterwards that no test had been made of the device.

There are other instances that could be related, but these two about cover, in my estimation, the proper answer to your correspondent's inquiry; that is, that the friction draft gear is not more generally used because of the prejudice existing against any improvements whatever by railroads in general on account of preconceived notions of service values born years and years ago, and, second, because there is a prejudice against using anything on a railroad, however meritorious it may be and however much it may save the car structures in the long run, if the device itself costs more than the cheapest thing that can be bought.

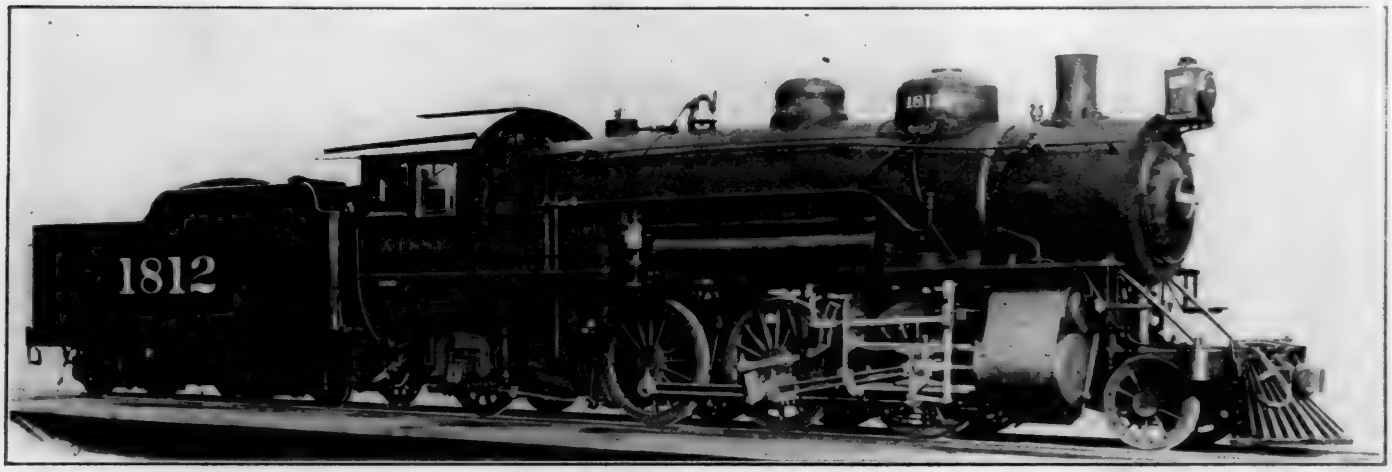
There is no question in my mind but that the manufacturers of draft gear, taking them all into consideration, have produced and are offering to the railroads, devices that are materially beneficial to the car people of the United States, and it is up to the car people to pass upon their merits and to act.

The suggestion of your correspondent that the Master Car Builder's Association take up the question of testing draft gear

seems to me to be a superfluous one, inasmuch as your correspondent himself mentions the fact that this subject was very thoroughly covered in 1902. The tests made by the Western Railway Club and by the Master Car Builder's Association in 1902, which tests have been pretty thoroughly published, seem to me to cover the case, and it would be useless to go into the subject any further in this way. There have been within the past two years additional tests of draft gear made by several railroads, and the results of these have been so confusing that it was difficult if not impossible to tell which, if any, of the draft gears tested came out best, and this would be the result of every other individual test made by a railroad, except in actual service.

I cannot understand what your correspondent means by saying that whereas the advantages of friction draft gear are usually stated in general terms they have not been reduced to a dollar-and-cent basis. If this is true in the case of your correspondent, the commercial engineers of the draft gear business must have changed their practice very materially since I went out of service, for I am quite sure that all of these gentlemen that visited me had this proposition reduced to a comparative basis as to cost and maintenance, and I believe that if your correspondent wants to get this kind of a comparison he can do so very quickly by taking the subject up with any of the manufacturers of a friction device.

New York, N. Y. X. R. R.



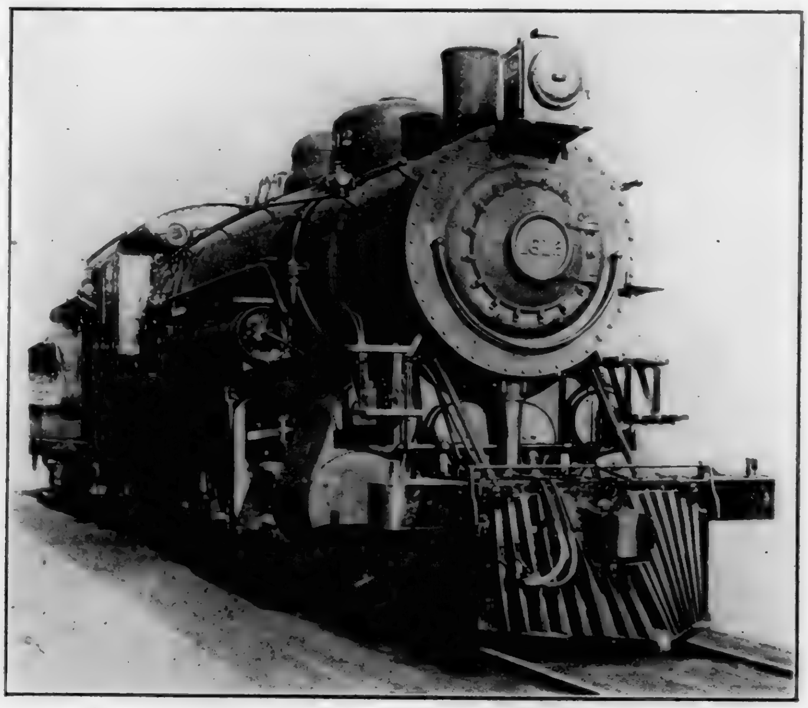
BALANCED COMPOUND LOCOMOTIVE WITH INCLINED HIGH PRESSURE CYLINDERS.—A., T. & S. F. RY.

FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE WITH INCLINED HIGH PRESSURE CYLINDERS.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

On page 434 of the November issue of this journal was illustrated and described a very large and powerful Prairie type locomotive, an order of which was recently built by the Baldwin Locomotive Works for the Atchison, Topeka & Santa Fe Railway. At that time were shown the general elevations of the locomotive, and the interesting numerical computation for obtaining the proper counterbalance weights to be placed in the driving wheels, which weights, due to the inclination of the high pressure cylinders, were found to vary nearly 500 lbs. between the two main driving wheels on the same axle. We are now able to show photographic illustrations and other details of these powerful locomotives.

As mentioned in the previous article, the raising and inclination of the high-pressure cylinders for the purpose of having the inside main rod pass over the front driving axle and connect to the second cranked axle introduces no particular complication outside of the cylinders and counterbalance. A study of the illustrations of the cylinders given herewith will show how the ports and connections between the valve chamber and the two cylinders, whose centre lines are not in the same horizontal plane have been arranged. This is the largest four-cylinder balanced compound locomotive ever built, and for the purpose of giving sufficient port openings to furnish a 17½-in. high-pressure cylinder with steam a 15-in. hollow piston valve has been used, which, together with its bushing, is also illustrated. It will be seen that the passages in the cylinder casting have been made in all cases as liberal and direct as possible. The passage from the valve chamber to the high-pressure cylinder is the one which has the most tortuous route to follow, since the admission is from the centre of the valve. As the passage to one of the cylinders must necessarily come from near the centre of the valve chamber, it is advisable to make this the high-pressure passage in preference to the low-pressure, because of a quicker movement and less volume of the high-pressure steam, outside of other considerations.



VIEW SHOWING CYLINDERS OF BALANCED COMPOUND LOCOMOTIVE. A., T. & S. F. RY.

The illustration clearly shows the details of the single piston valve, having six sets of packing rings which control the steam for both cylinders. It will be noticed that the port openings through the bushings are 1½ ins. wide in all cases, except the live steam admission port, which is 3 ins. wide. This gives 108 1-3 sq. in. port opening for admission to the valve chamber and 54.2 sq. in. area for a full port opening into either of the cylinders and to the exhaust.

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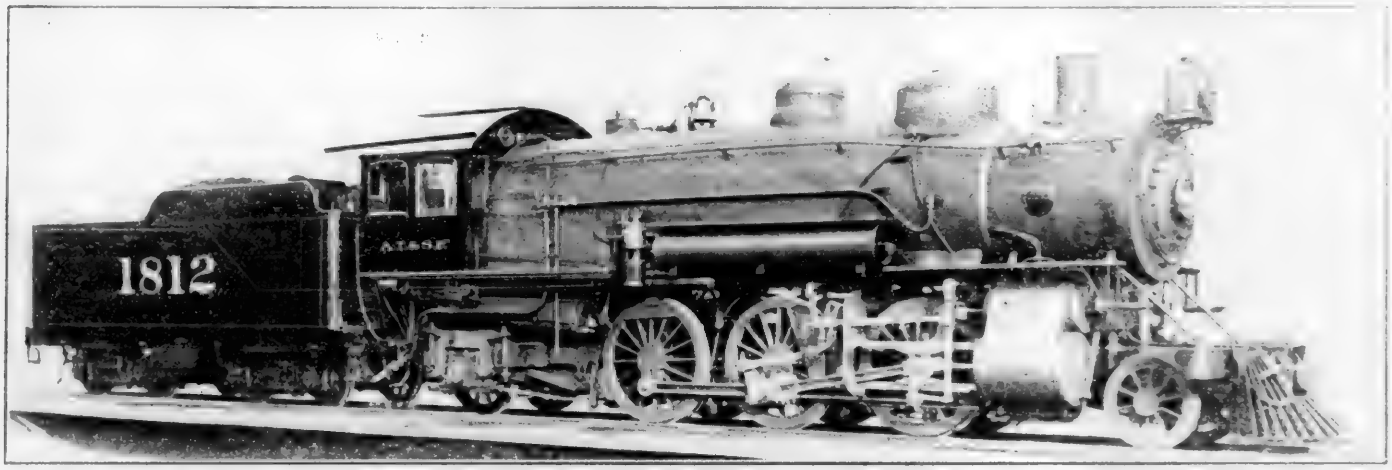
New York, N. Y. X. R. R.



BALANCED COMPOUND LOCOMOTIVE WITH INCLINED HIGH PRESSURE CYLINDERS.—A., T. & S. F. RY.

FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE WITH INCLINED HIGH PRESSURE CYLINDERS.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

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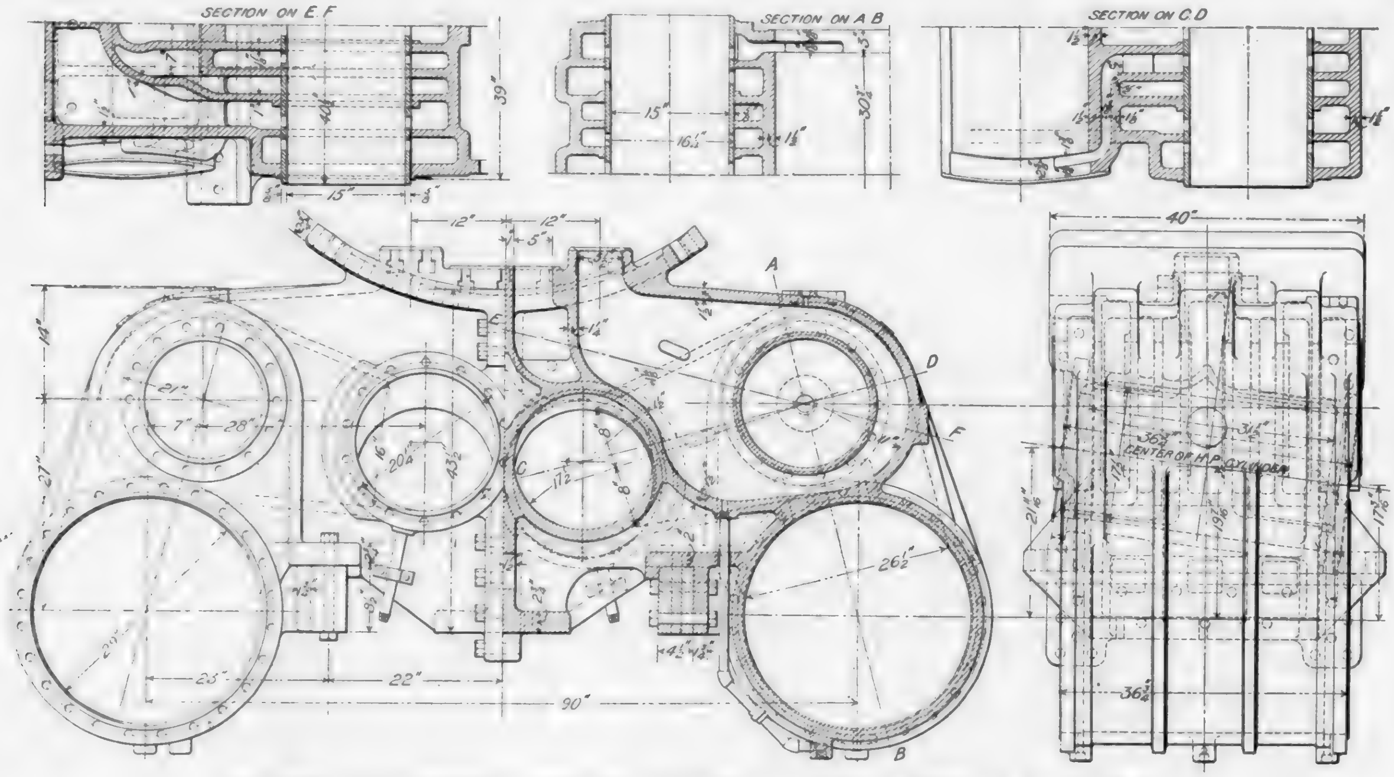
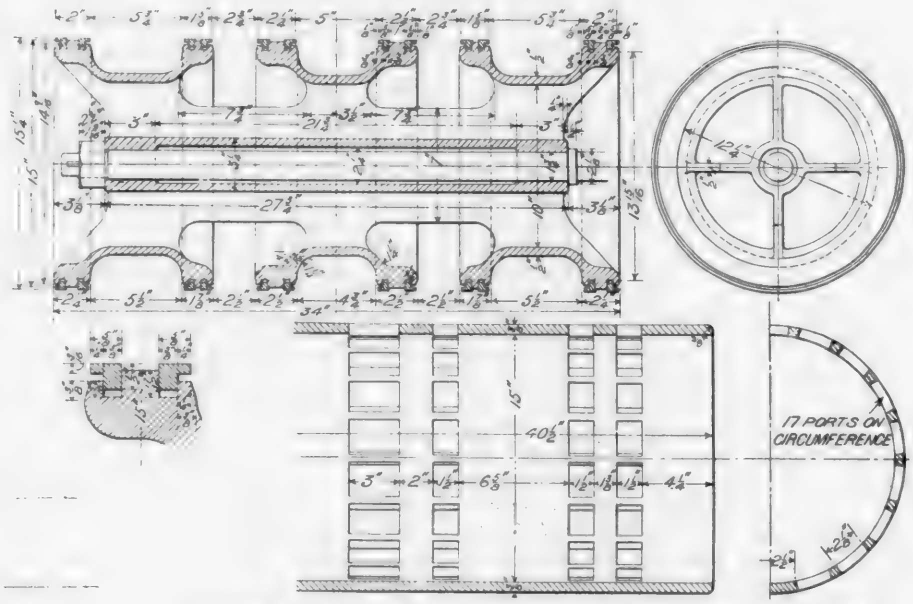
VIEW SHOWING CYLINDERS OF BALANCED COMPOUND LOCOMOTIVE.
A., T. & S. F. RY.

The illustration clearly shows the details of the single piston valve, having six sets of packing rings which control the steam for both cylinders. It will be noticed that the port openings through the bushings are 1½ ins. wide in all cases except the live steam admission port, which is 3 ins. wide. This gives 108 1-3 sq. in. port opening for admission to the valve chamber and 51.2 sq. in. area for a full port opening into either of the cylinders and to the exhaust.

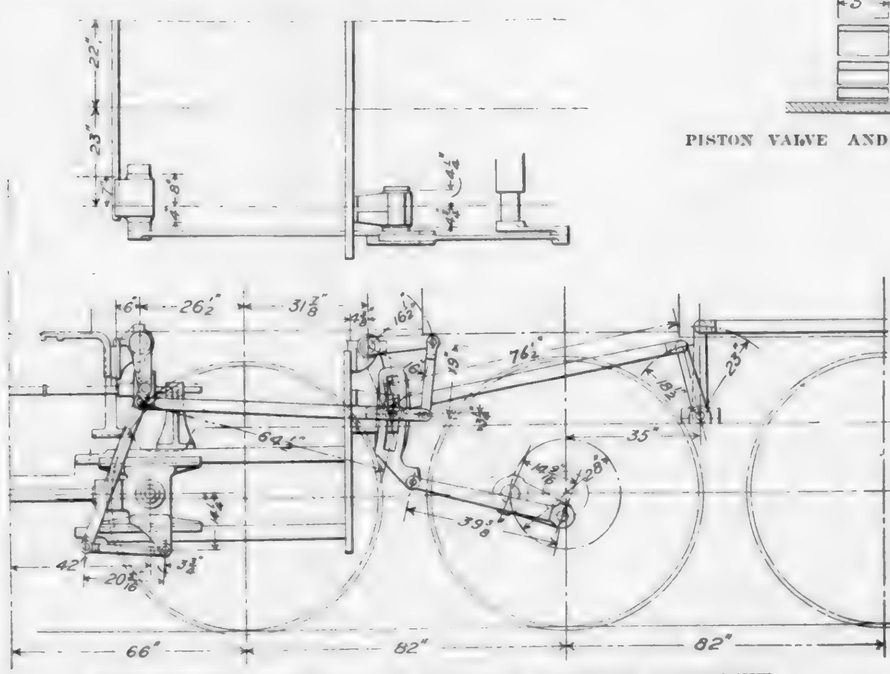


CYLINDERS OF BALANCED COMPOUND LOCOMOTIVE.—ATCHISON, TOPEKA & SANTA FE RY.

In the design of the Walschaert valve gear as applied to a balanced compound locomotive, it is unadvisable to place the valve chamber in a position to have the whole motion in practically one vertical plane, as can be done with a simple engine, and hence the motion is transmitted from the top of the combination lever to a rocker arm, supported just back of the cylinders, the inside arm of which operates the valve rod through a crosshead connection. The illustration shows the method of connecting the reverse mechanism, which employs two reverse shafts, one placed just above the link and supported from the guide yoke, and the other on the frame back of the main drivers.



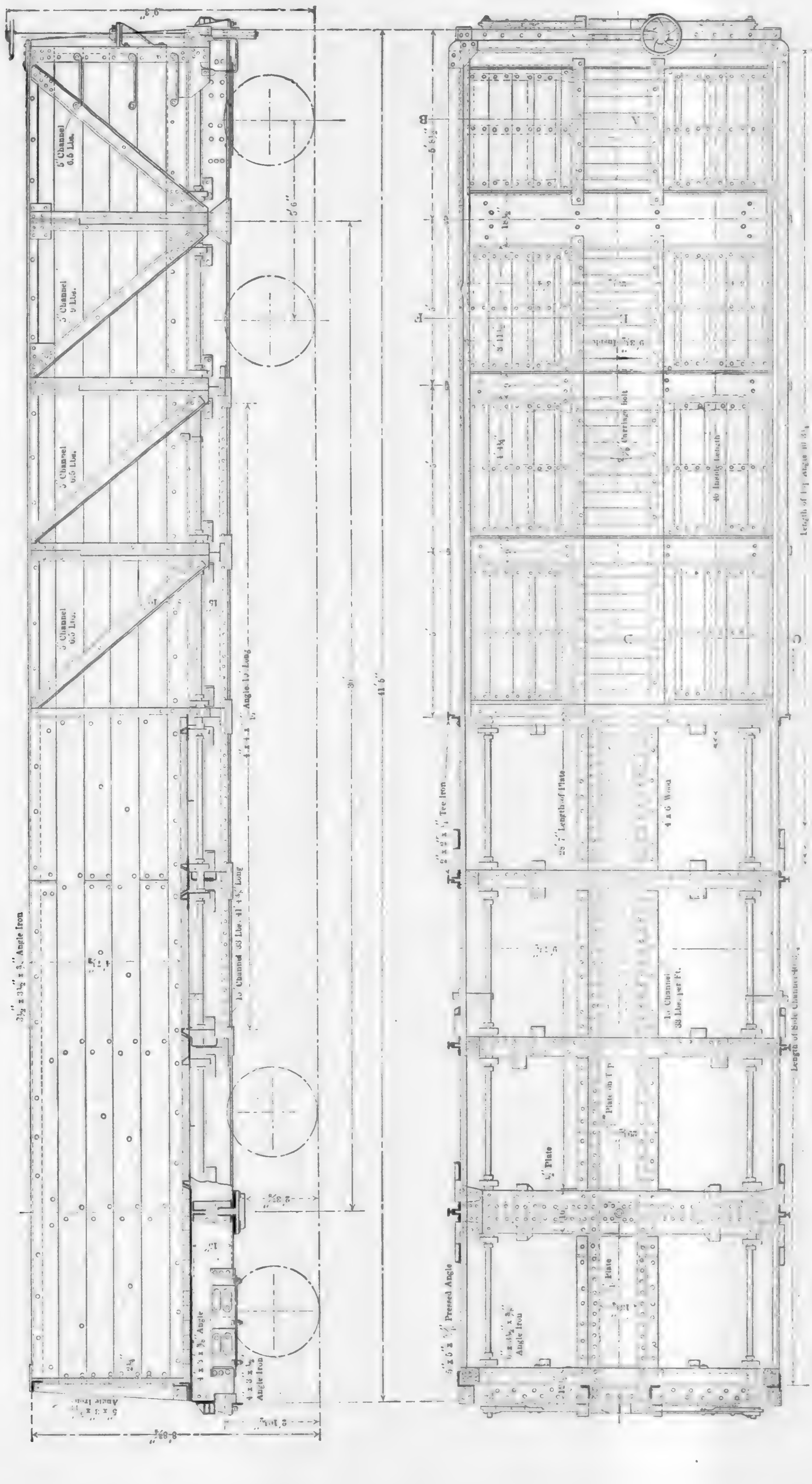
PISTON VALVE AND BUSHING, BALANCED COMPOUND LOCOMOTIVE.



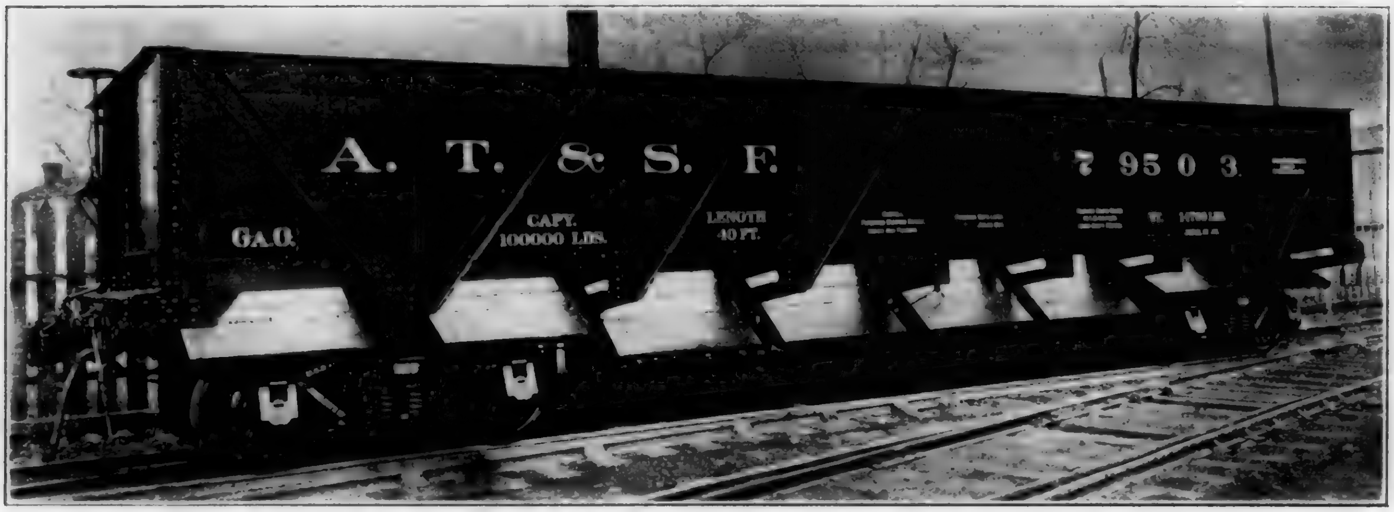
WALSCHAERT VALVE GEAR ON BALANCED COMPOUND LOCOMOTIVE.

Harder Car Wheel Chills.—A United States patent has recently been issued for the treatment of car-wheel iron in the ladle with powdered Rutile, the chief ore of titanium, for the purpose of increasing the hardness of the chilled tread.

Railroads in Oklahoma.—When the new State of Oklahoma is admitted to the Union next May it is estimated that it will have 6,000 miles of railroad in operation. It has 3,000 miles now, and 3,000 miles more are expected to be completed by June 1, 1907. It is believed that no other State ever came into the Union with such extensive transportation facilities.—*Iron Age.*



50-TON STEEL FRAME GONDOLA CAR.—ATCHISON, TOPEKA & SANTA FE RAILWAY.



50-TON STEEL FRAME GONDOLA CAR.—SANTA FE SYSTEM.

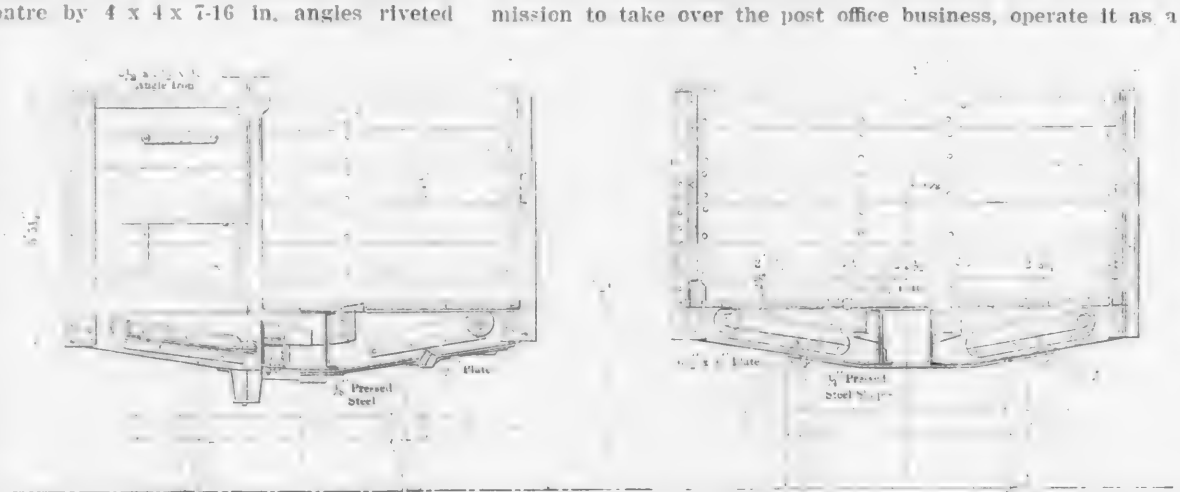
50-TON STEEL FRAME GONDOLA CAR.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

The 40 ft. steel frame gondola cars, 100,000 lbs. capacity, illustrated herewith, have been in service on the Santa Fe for about a year and were built at the Jeffersonville works of the American Car & Foundry Company. They are used largely for hauling coal, gravel and rock ballast and are equipped with 16 drop doors operated by what is known as a Santa Fe modification of the Caswell drop door mechanism, similar to that used on the steel underframe stock and coke cars described on page 417 of our November issue. They weigh 44,700 lbs. each and have the following general dimensions:

Length over end sills	41 ft. 5 ins.
Length inside	40 ft.
Width over stakes	10 ft. 2⅝ ins.
Width over sideboards	9 ft. 7½ ins.
Width inside	9 ft. 3½ ins.
Height inside of box	4 ft. 7¼ ins.
Height, top of rail to top of sideboard	8 ft. 8½ ins.
Height, top of rail to top of brake staff	9 ft. 3 ins.
Wheel base of car	35 ft. 6 ins.
Wheel base of truck	5 ft. 6 ins.
Distance between truck centers	30 ft.

The centre sills consist of 15 in., 33 lb., channels reinforced for 19 ft. at the centre by 4 x 4 x 7-16 in. angles riveted to the inside of the webs at the bottom. They are also reinforced by a 5-16 in. cover plate. The side sills are 8 in., 11¼ lb., channels. The cross ties are of pressed steel ¼ in. thick with 3¼ in. flanges. They are reinforced at the top with a 5-16 x 6½ in. plate and at the bottom by a ⅜ x 6½ in. plate, these plates extending the full width of the car and securely tying the various parts together, as shown in the illustrations.



End View Section A-B Section C-D Section E-F

PART END VIEW AND CROSS-SECTIONS OF SANTA FE GONDOLA CAR.

The members of the body bolster are of pressed steel with 3½ in. flanges. They are securely riveted to the centre sills and are tied together by a ½ in. plate at the top and a ⅝ in. plate at the bottom. The end sills are of pressed steel 5-16 in. thick and are reinforced with a heavy angle at the top. They are securely attached to the centre sills as shown on the drawing. The dead blocks are of malleable iron. Miner tandem draft gear is used.

The floor supports are of yellow pine and are secured to the centre sills by malleable iron brackets. The flooring is 2¼ ins. thick. The side stakes are built up of 3 x 3 x 5-16 in. angles and 2 x 2 x ¼ in. T's. They are riveted to the side channels, to the gusset plates and to the top side angle. The side braces are 5 in., 6½ lb., channels except the first and intermediate, which are 9 lbs. to a foot. These braces are riveted to the gusset plates, the side channels and to the 3½ x 3½ x ⅜ in. top side angle. The end stakes are 3 x 5 x 5-16 in. angles and are secured at the bottom with ¼ x 5 in. bent steel plates and at the top to 5 x 8½ x ¼ in. gusset plates and to the 3½ x 3½ x ⅜ in. top angle. The corner bands are 5 x 5 x 5-16 in. angles. The side boards are 2 x 10 in.

We are indebted for information and drawings to Mr. A. Lovell, superintendent of motive power, and Mr. E. Posson, engineer of car construction.

PROPOSAL TO MAKE POST OFFICE PRIVATE CONCERN.—Mr. W. D. Boyce, of Chicago, has made a proposal to the Postal Commission to take over the post office business, operate it as a private corporation under full Government regulation and reduce by one-half all postal rates, establish rural postal express and apply business methods throughout.

THE TUNNEL UNDER CAPITOL HILL at Washington, by which the Pennsylvania Railroad will reach the new union station has been completed. This tunnel is 4,033 ft. long and consists

of two tubes separated by a masonry wall, each tube carrying a single track. Through this tunnel, trains to and from the South will secure direct communication with the new terminal station.

Photographic Cars for use of official photographers have been introduced upon the Southern Pacific Railroad. Each provides professional equipment and living rooms for four photographers.

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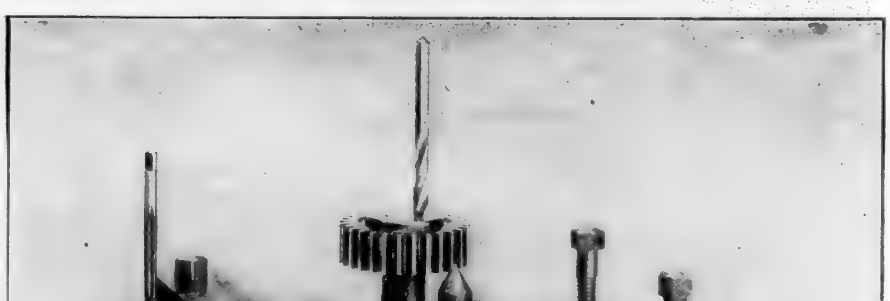
DRILL PRESS CHUCK.

A very convenient and useful chuck adapted for use with drill presses, milling machines, shapers and planers, has recently been placed on the market by the Cincinnati Machine Tool Company, Cincinnati, O. The chuck will hold flat, round, straight or taper work equally well, adjusting itself to the shape of the work and holding it securely. The steel blocks used in the chuck are planed from bar machinery steel, and have different sizes of V's planed true and square at different angles. These blocks may readily be removed by passing the heads of the clamping screws through T slots in the body of the chuck. This allows the blocks to be used as regular V or parallel blocks. The steel jaws attached to the body of the chuck may be removed by taking out the hexagon head screws



CHUCK FOR DRILL PRESSES, MILLING MACHINES, SHAPERS, ETC.

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A NEW FLEXIBLE STAY-BOLT.

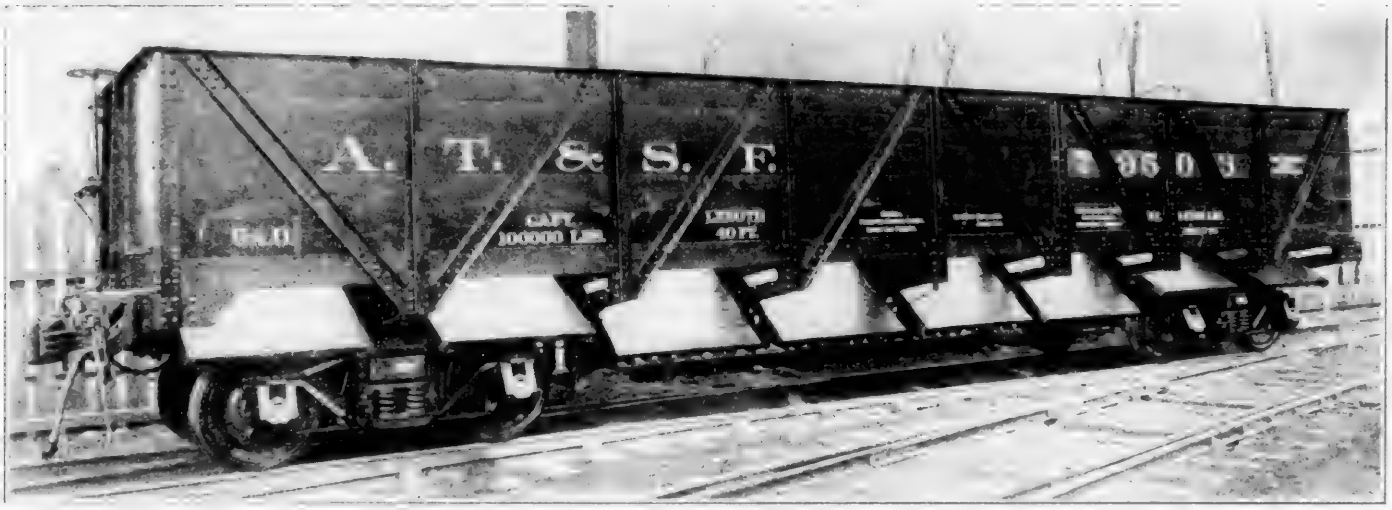
The question of using flexible staybolts in certain sections of locomotive fireboxes is one which has been particularly prominent since the general introduction of the large high-pressure modern boiler during the past few years. It was condensed and clarified to a large extent by the report of the committee appointed by the American Railway Master Mechanics' Association to investigate the subject, which was presented at the last convention. This committee had made extensive experi-

NEW FLEXIBLE STAYBOLT.

ments and clearly showed that there was a decided movement of the two sheets of the firebox relative to each other, which movement varied widely at different points in the firebox and under different firing conditions. The report also stated that the flexible stay-bolts then in use were successful when of the proper design and that their use had resulted in a big improvement in boiler conditions. The principal condition which defeated their purpose was the use of water giving a hard scale, and the importance of this point has been largely nullified by the improvements in design of the later types of flexible stay-bolts.

Since the report of this committee was presented an entirely new design of flexible staybolt has been patented which is distinctly different from the most successful of the previous types, in that it employs the principle of the eye bolt for its flexibility instead of a ball-and-socket joint. This bolt, which is illustrated herewith, is being placed on the market by The Flexible Bolt Company, 42 Broadway, New York, and consists of a drop-forged, mild steel eye head, through which a round rod of stay-bolt iron is passed and bent into a U shape. The center of this U, above the eye is then filled by a special shaped piece of iron and the three pieces are heated to a welding heat and forged down to 1 in. in diameter, care being taken that the connection at the eye is kept cool during this operation. This gives a bolt which has free latitudinal movement for a sufficient distance to answer all purposes, but is so constructed that there is practically no lost motion longitudinally. The eye, or head, section is then threaded with a taper thread and the opposite end with a standard stay-bolt thread, the two threads being cut in pitch. It is placed in the firebox and screwed into place by means of a wrench fitting in the square hole in the outer head. The inner end can be riveted over, the same as with a solid stay-bolt, since the force of the blow is transmitted directly through to the outer end without lost motion. It has the further advantage of leaving a practically smooth outside sheet, to which the lagging, cab brackets and other boiler attachments can be applied with little difficulty.

The experiments so far made show that a deposit of hard scale will not prevent the action of this bolt, since its movement is always such as to force the scale away from the metal. If this feature proves itself after a long service, the greatest difficulty with flexible stay-bolts in bad water districts will be eliminated.



50-TON STEEL FRAME GONDOLA CAR.—SANTA FE SYSTEM.

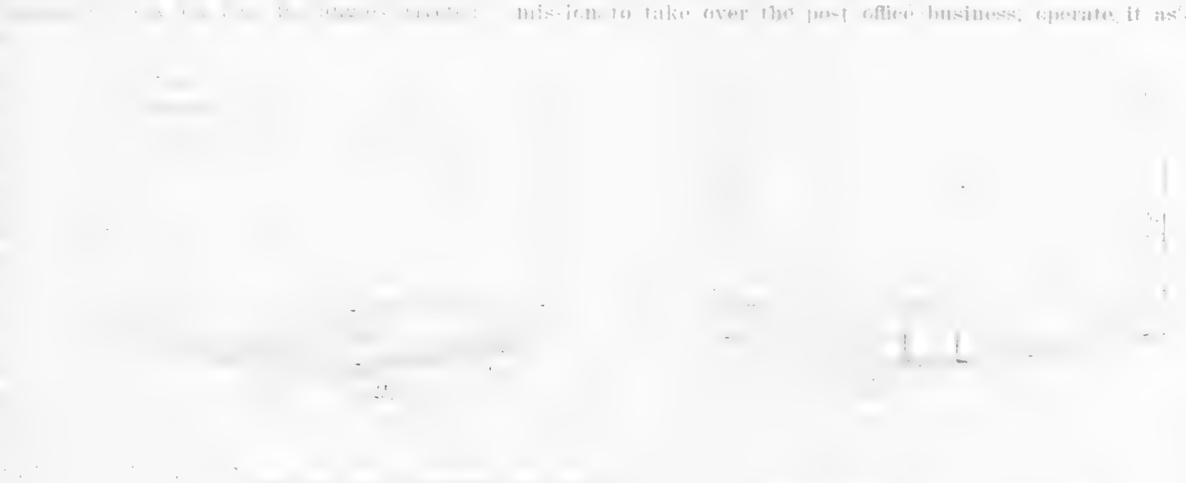
50-TON STEEL FRAME GONDOLA CAR.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

The 40 ft. steel frame gondola cars, 100,000 lbs. capacity, illustrated herewith, have been in service on the Santa Fe for about a year and were built at the Jeffersonville works of the American Car & Foundry Company. They are used largely for hauling coal, gravel and rock ballast and are equipped with 16 drop doors operated by what is known as a Santa Fe modification of the Caswell drop door mechanism, similar to that used on the steel underframe stock and coke cars described on page 417 of our November issue. They weigh 41,700 lbs. each and [illegible]

Length [illegible]	41 ft.
[illegible]	40 ft.
[illegible]	40 ft. [illegible] ins.
Width over side [illegible]	[illegible] ft. 7½ in.
Width [illegible]	9 ft.
[illegible]	4 ft. 7¼ [illegible]
[illegible]	8 ft. 8½ ins.
Height, top of rail to top of brake staff	9 ft. 3[illegible] ins.
[illegible]	[illegible]

The centre sills consist of 15 in., 33 lb., channels reinforced [illegible] bottom. They are [illegible] sills are 8 in., 11¼ lb., channels. The [illegible] pressed steel [illegible] in. thick with 3[illegible] in. flanges. They are reinforced at the top with [illegible] plate and at the bottom by a ⅜ x [illegible] 6½ in. plate, these plates extending the full width of the car and securely tying the various parts together, as shown in the illustrations.



End View Section A-[illegible] Section [illegible]-D Section E-F

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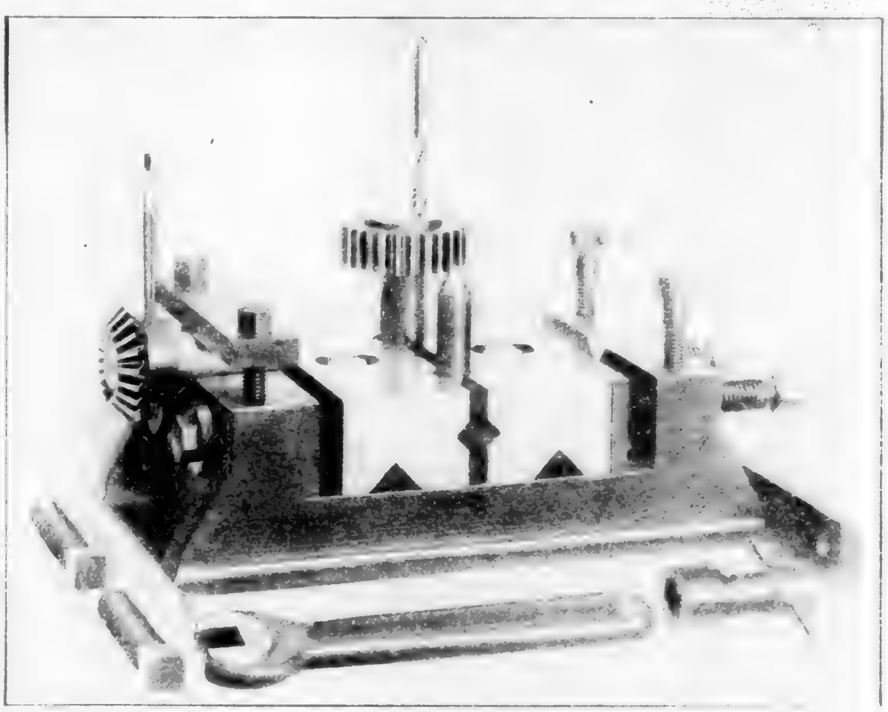

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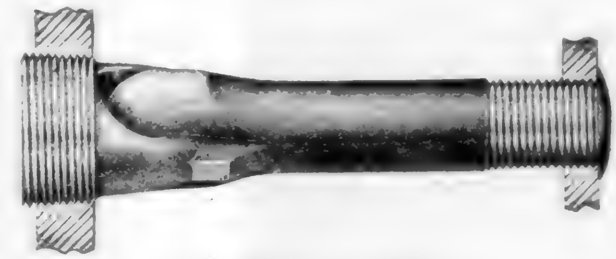

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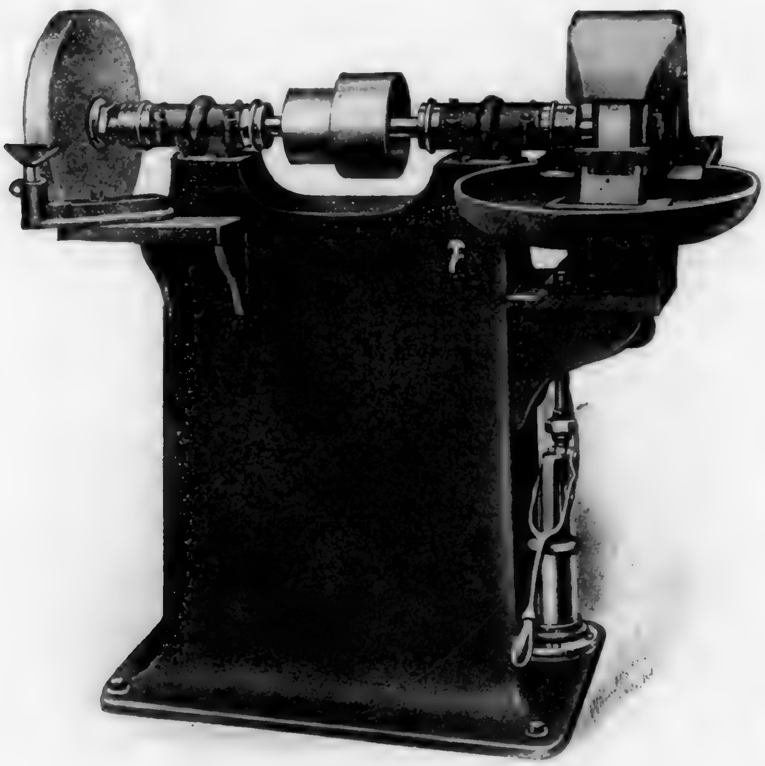
COMBINATION WET AND DRY GRINDER.

The combination wet and dry grinder, illustrated herewith, was designed for use in small shops, or in places where cramped for room and it is desired to do a variety of grinding on one machine. The dry grinder end is intended for grinding small pieces, castings or other rough work, and if desired may be arranged with a small surfacing table over the wheel for doing surface work. The wet grinding end is arranged for grinding tools.



COMBINATION WET AND DRY GRINDER.

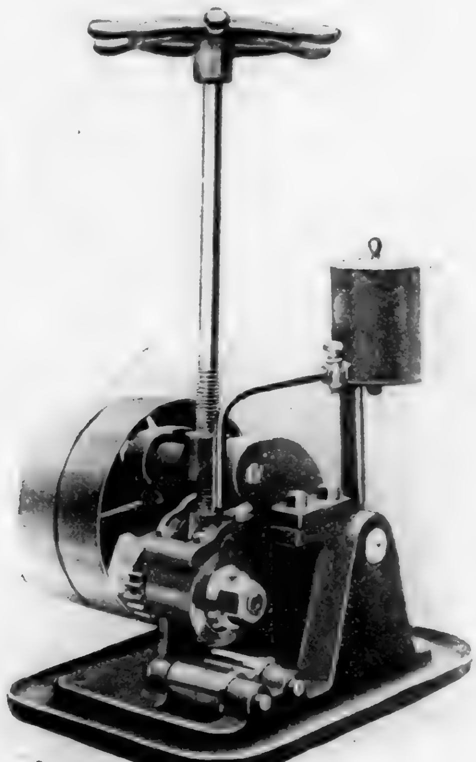
The bearings are ring oiling, of phosphor bronze, split, with removable sleeves. If the bearings become worn new sleeves can readily be applied. Each bearing has a large oil reservoir and an oil return from each end. Ring check nuts are used in connection with the dust collars at the end of each bearing, these check nuts being positive in their action in taking up end play.

The lower part of the base of the machine consists of a large air-tight water tank. Above this tank is another smaller one connected to it by a pipe, which extends from near the bottom of the lower tank to the normal water level in the upper one. In order to raise the water level in the upper tank to come in contact with the grinding wheel it is only necessary to give a few strokes to the air pump, thus forcing the air above the water in the lower tank, causing the water to flow to the upper one. Opening the small angle cock at the front of the machine allows that part of the water above the level of the top of the pipe to pass from the upper tank into the lower one. The sediment from the grinding settles to the bottom of the upper tank and may easily be removed when a new wheel is put in. As the connecting pipe extends almost to the bottom of the lower tank, and as this has a large storage capacity, one filling will last for a long time. To refill a tank it is only necessary to open the air cock and pour water into the bowl of the tool grinder until it begins to run out of the cock.

These machines are made in three sizes, carrying wheels 18, 20 and 26 ins. in diameter, by The Bridgeport Safety Emery Wheel Company, Inc., of Bridgeport, Conn.

NEW ROLLING PIPE CUTTER.

An improved rolling pipe and tube cutter has recently been designed by the Bignall & Keeler Mfg. Co. of Edwardsville, Ill., and is illustrated herewith. The driving shaft is connected to the cutter shaft by cut gears. The driving shaft is connected to by a screw working in a steel nut. The rollers are of large diameter and run on hardened steel pins. The cutter disc is made of the best tool steel carefully tempered and is stiffened by a pair of steel flanges. An oil tank and pan are furnished as shown. These machines are made in two sizes; No. 1 cutting from ¼ to 2 ins. and No. 2 from 1 to 4 ins.



NEW PIPE CUTTER.

THE TECHNICAL JOURNAL is a co-operative exchange. Its business is to tell the story, week by week or month by month, of current progress. Its pages are wide open to the man with a record of progress—real progress and not mere blowing of horns—if that record will be of practical service to the readers. The editor's function is like that of a baseball umpire—to say what is a hit and what is a foul and to endure with patience the objurgations of those who object to his decisions. —*Charles Whiting Baker, Editor Engineering News, at the dedication of the University of Pennsylvania Engineering Building.*

PERSONALS.

Mr. R. R. Douk has been appointed general foreman of the Wabash R. R. at Montpelier, Ohio.

Mr. George W. Miller has resigned as general foreman of shops of the Erie R. R. at Elmira, N. Y.

Mr. M. W. Fitzgerald has been appointed master mechanic of the Illinois Southern Ry., with office at Sparta, Ill.

Mr. Wm. Thornton has been appointed foreman of the car department of the Orange & Northwestern Ry., at Orange, Tex.

Mr. William Cormack of Stevens Point, Wis., for twenty years master car builder of the Wisconsin Central, is dead, aged 69.

Mr. James Fitzgerald, master mechanic of the Cleveland, Cincinnati, Chicago & St. Louis Ry. at Bellefontaine, Ohio, is dead.

Mr. W. H. Dempsey has been appointed mechanical engineer of the Atlanta, Birmingham & Atlantic Railroad Company at Fitzgerald, Ga.

Mr. F. A. Smock has been appointed master mechanic of the Pennsylvania R. R. at Meadows, N. J., to succeed Mr. J. W. Sanford, retired.

Mr. H. J. Trein has been appointed master mechanic of the Denver, Enid & Gulf Railway at Enid, Okla., to succeed Mr. John Rohrig.

Mr. R. F. Tyne, locomotive foreman at Brandon, Man., has been appointed master mechanic of the Canadian Pacific Ry. at Moose Jaw, Sask.

Mr. R. Griffith has been appointed master mechanic of the Colorado Midland Ry., at Colorado City, Colo., vice Mr. W. J. Schlacks, resigned.

Mr. Edward F. Fay has been appointed general foreman of the Omaha shops of the Union Pacific Railroad, succeeding Mr. Stovel, promoted.

Mr. H. Stovel has been appointed superintendent of shops of the Union Pacific Railroad at Omaha, Neb., succeeding Mr. A. W. Whiteford, resigned.

Mr. H. S. Wall has been transferred to Needles, Cal., as master mechanic of the Arizona division of the Atchison, Topeka & Santa Fe (Coast Lines).

Mr. T. R. Shanks has been appointed master mechanic of the East Broad Top Railroad, with office at Orbisonia, Pa., vice Edgar Shellaberger, deceased.

Mr. S. J. Ask has been appointed assistant road foreman of engines on the eastern division of the Lake Shore & Michigan Southern Ry. at Buffalo, N. Y.

Mr. J. W. Ruffner has been appointed master mechanic of the St. Louis Iron Mountain & Southern Ry. at Ferriday, La., in place of Mr. J. B. Tennant, resigned.

Mr. Walter Reid has been appointed road foreman of engines of the Arizona division of the Atchison, Topeka & Santa Fe (Coast Lines) at Needles, Cal.

Mr. E. J. Bouchard has been appointed superintendent of motive power and rolling stock of the Sierra Railway of California, with headquarters at Jamestown, Cal.

Mr. E. W. Woodhouse, district master mechanic of the Canadian Pacific Ry. at Moose Jaw, has been transferred to Calgary, Alta., vice Mr. John Cardwell, transferred.

Mr. David O. Shaver, formerly from March, 1867, to February, 1900, master mechanic of the shops of the Pennsylvania Railroad at Pittsburgh, Pa., is dead, aged 74 years.

Mr. M. P. Cheney, has been transferred to San Bernardino, Cal., as road foreman of engines of the Los Angeles division of the Atchison, Topeka & Santa Fe (Coast Lines).

Mr. Joseph Walker, of Paducah, Ky., has been appointed general foreman of the mechanical department of the Nashville & Evansville division of the Illinois Central R. R.

Mr. J. F. Enright, master mechanic of the Mobile & Ohio Railroad at Whistler, Ala., has been appointed to have jurisdiction also over the Southern Railway in Mississippi.

Mr. S. E. Thompson has been appointed assistant engineer of motive power of the Pennsylvania Railroad at Buffalo, N. Y.

Mr. Michael Malican has been appointed roundhouse superintendent of the New York Central Lines at East Buffalo, N. Y.

Mr. F. W. Malott, general foreman of shops at South Tacoma, has been appointed to succeed Mr. Crosby as superintendent of shops of the Northern Pacific Ry. at South Tacoma, Wash.

Mr. F. W. Mahl, master mechanic of the Southern Pacific Ry. at Sacramento, Cal., has resigned to accept a similar position with the Colorado & Southern Ry. with headquarters at Denver.

Mr. C. S. Kessler, foreman of car inspectors in the shops of the Pennsylvania Railroad at Sunbury, Pa., has been promoted to assistant to the general car inspector at Williamsport.

Mr. L. L. Young, acting master mechanic of the Detroit, Toledo & Ironton Ry. at Springfield, Ohio, is dead. Mr. Young had previously been traveling engineer and was promoted only one month ago.

Mr. James McQuillan, roundhouse foreman at Gainesville, Tex., has been appointed to succeed Mr. Robinson as division master mechanic of the Gulf, Colorado & Santa Fe Railway at Silsbee, Tex.

Mr. Thomas Malloy, master mechanic of the Albany & Hudson R. R., has resigned to become assistant superintendent of equipment on the Harlem division of the New York Central & Hudson River R. R.

Mr. W. A. George has been appointed master mechanic of the second and third districts of the Albuquerque division of the Atchison, Topeka & Santa Fe (Coast Lines), with headquarters at Winslow, Ariz.

Mr. J. B. Kilpatrick has been appointed superintendent of motive power of the Chicago, Rock Island & Pacific Ry., with office at Chicago, succeeding L. W. Harrison, acting superintendent of motive power.

Mr. M. Robinson, division master mechanic of the Gulf, Colorado & Santa Fe Railway at Silsbee, Tex., has been transferred to Temple, Tex., in a similar capacity, succeeding Mr. P. T. Dunlop, promoted.

Mr. George S. McKee, superintendent of motive power and car equipment of the Mobile & Ohio R. R., with office at Mobile, Ala., has had his jurisdiction extended over the Southern Railway Company in Mississippi.

Mr. R. M. Crosby, superintendent of shops of the Northern Pacific Ry. at South Tacoma, Wash., has been appointed general master mechanic of the Western division, with office at Tacoma, succeeding Mr. W. Moir.

Mr. A. J. Ball, master mechanic of the Toledo Railway & Terminal Company, Toledo, Ohio, has been appointed superintendent of motive power of the Detroit, Toledo & Ironton Ry., with headquarters at Jackson, Mich.

Mr. C. L. Acker, roundhouse foreman of the Baldwin Locomotive Works at Philadelphia, Pa., has been appointed master mechanic of the Toledo Railway & Terminal Company at Toledo, Ohio., succeeding Mr. A. J. Ball, resigned.

Mr. E. G. Haskins, heretofore acting master mechanic of the Denver & Rio Grande R. R. at Salida, Colo., has been appointed master mechanic of the Rio Grande Western Ry. at Salt Lake City, Utah, succeeding Mr. William Donald, resigned.

Mr. G. A. Gallagher has been appointed master mechanic of the Southern Indiana Ry., with headquarters at Bedford, Ind.

Mr. Robert D. Fidler, heretofore roundhouse foreman of the Chicago, Indianapolis & Louisville Ry. at Lafayette, Ind., has been appointed assistant master mechanic of the Cincinnati, Hamilton & Dayton Ry. at Indianapolis, Ind.

Mr. P. T. Dunlop, division master mechanic of the Atchison, Topeka & Santa Fe Ry. at Temple, Texas, has been promoted to mechanical superintendent, with headquarters at Cleburne, Texas. Mr. Dunlop suceeds Mr. A. Harrity, resigned.

Mr. M. J. Drury, master mechanic of the Atchison, Topeka & Santa Fe Ry. at Raton, N. M., has been appointed mechanical superintendent of the Western Grand Division, with headquarters at La Junta, Colo., succeeding Mr. C. M. Taylor, resigned.

Mr. A. W. Whiteford, heretofore superintendent of shops of the Union Pacific Railroad at Omaha, Neb., has been appointed shop superintendent of the Lehigh Valley Railroad with headquarters at Sayre, Pa., succeeding Mr. E. T. James, resigned.

Mr. R. D. Smith, formerly superintendent of motive power of the Chicago, Burlington & Quincy Ry., at Lincoln, Neb., has been appointed mechanical expert of the New York Central, in charge of special work on the lines west of Buffalo, reporting to Mr. J. F. Deems, general superintendent of motive power. Mr. Smith's appointment was effective October 1, and his office is at La Salle Street Station, Chicago.

BOOKS.

The *Mechanical World* Pocket Diary and Year Book for 1907. Pocket size, $4\frac{1}{4}$ x $6\frac{1}{4}$. 302 pages. Published by Emott & Company, Ltd., 65 King Street, Manchester, England. Price, sixpence.

This is the twentieth year of publication of this well-known pocket diary and year book, which is filled with useful engineering notes, rules, tables and data. It also contains about 60 blank pages with the dates for the year 1907, to be used as a diary or memoranda.

Text-Book on Geodesy and Least Squares. By Charles L. Crandall, Professor of Railroad Engineering and Geodesy, Cornell University. Published by John Wiley & Sons, New York, 1906. Price, $3.00.

This book is an outgrowth of a course of lectures prepared for instruction at Cornell at a time when there was but little available in English on the subject outside of the Coast Survey Reports. They were revised from time to time, and have now been elaborated and brought strictly up to the best standard practice and put into text-book form. The book is well illustrated and all parts of the subject are treated in a clear, concise manner.

The Steel Square as a Calculating Machine. By Albert Fair. 81 pages. Cloth, 5 x $7\frac{1}{2}$. Published by the Industrial Publication Company, New York. Price, 50 cents.

This is an elementary work intended for the use of the comparatively uneducated workman or beginner. The matter is all simple, and shows how some very unexpected problems can be easily solved by the use of the ordinary steel square. Many of these would take tedious numerical work to perform, but can be quickly and easily solved by the methods shown. The entire work is simple and easily understood, and answers the purpose intended in a very satisfactory manner.

Proceedings of the American Railway Engineering and Maintenance of Way Association. Seventh annual convention, Chicago, 1906. Published by the Association. E. H. Fritch, Assistant Secretary, Chicago.

This volume, of 824 pages, contains the committee reports presented at the last convention, together with the discussion on them, list of members and mileage of roads represented, constitution and officers. The committee reports include those on ties, ballasting, yards and terminals, iron and steel structures; records, reports and accounts; classification of track; roadway; signs, fences, crossings and cattle-guards; signaling and interlocking, rails, masonry, buildings, track, water service and wooden bridges and trestles.

Proceedings of the Master Car Builders' Association. Fortieth annual convention, Atlantic City, June, 1906. Published by the Association, J. W. Taylor, Secretary, 390 Old Colony Building, Chicago.

In addition to the complete committee reports, discussion of the reports, and topical discussions, this volume contains the revised rules and corrected standards and recommended practice of the association.

Turning and Boring Tapers. By Fred H. Colvin. Paper bound. 25 pages. Published by the Derry-Collard Company, New York. Price, 25 cents.

This is the first of a series of practical papers which are being published by this company, and is the second edition of the one on turning and boring tapers. It is clearly illustrated by line drawings, and shows the proper method of turning or boring tapers on a lathe, both with and without attachments. This includes straight and compound tapers, as well as tapered threads. A chapter is also included on turning tapers on boring mills. The matter is given in a clear and concise manner, and forms a valuable pamphlet for the use of shop foremen and machinists.

Proceedings of the American Railway Master Mechanics' Association. Thirty-ninth annual convention, Atlantic City, June, 1906. Published by the Association, J. W. Taylor, Secretary, 390 Old Colony Building, Chicago.

This volume contains the complete reports and discussion thereon of all the committees reporting at the last convention, which included those relating to locomotive front ends, flexible stay-bolts, wheel center design, classification of locomotive repairs, specifications for cylinder iron and electricity on steam roads, as well as individual papers on special valve gears, superheated steam and locomotive injectors. The excellent address of President H. F. Ball is given complete, and the volume also contains the standards and specifications of the association.

American Stationary Engineering. Facts, rules, and general information for the stationary engineer. By Mr. W. E. Crane. 285 pages, cloth. Published by the Derry-Dollard Company, New York. Price, $2.00.

This volume is intended for the managers and superintendents of power plants as well as the enginemen and firemen. It contains full directions for the care of stationary boilers, pumps and engines. A chapter is given on the repairs of stationary engines and pumps, which are all clearly illustrated by sketches. Other chapters deal with air pumps and condensers, belts, lubrication, chimneys, steam heating, piping, etc. A list of examination questions gives an idea of the features upon which the stationary engineer should be well informed.

Railroad Signal Association—Digest of Proceedings. Two volumes. Compiled under the direction of the executive committee. H. S. Balliet, Secretary, Grand Central Station, New York. Published by the Times Publishing Co., Bethlehem, Pa.

For the purpose of making the papers, reports and discussions of the Railway Signal Club and the Railway Signal Association more readily accessible for reference it was decided at the 1904 annual meeting to republish them, and these two cloth-bound volumes have now been completed. They contain a full report of all the meetings of the association since its birth, on March 11, 1895. The subjects have been arranged for easy reference, and Vol. II contains an index for both volumes. A list of members, corrected to August 24, 1906, and the revised constitution, adopted May 8, 1906, are included.

Air Compressors and Blowing Engines. By Chas. H. Innes, M. A. Published by D. Van Nostrand Company, New York. Price, $2.00.

As stated in the preface, this book deals with the construction of blowing engines and air compressors, and is reprinted from a series of articles which originally appeared in *The Practical Engineer*. The first chapter discusses the properties of air, and shows how to calculate the work required for compression under various circumstances. The second describes several experiments with compressors and explains the methods of calculating the various efficiencies. The third deals with the theory of valves for equalization of pressure, and the fourth is devoted to the construction of blowing engines. Chapter V commences the description of air compressors. These have self-acting valves, and the remainder of the book is devoted to those with mechanically controlled valves. The book is well illustrated.

Poor's Manual of Railroads, 1906, thirty-ninth annual number. Published by Poor's Railroad Manual Company, 68 William Street, New York. Price, $10.

The scope and size of this edition of the well-known Poor's Manual has been enlarged by the addition of several important features, previously published separately in "The Railroad Manual Appendix." These include all the data embraced in Poor's Ready Reference Bond List, as well as tables of annual meetings, transfer agencies, etc., and tables of dividends paid for eight years. These additions, in connection with the natural growth of the other matter and the insertion of more maps and an improved index, make this a volume of 1,800 pages. Many new industrial corporations have been included, as well as newly incorporated steam and electric railroads.

Marine Engineers: Their Qualifications and Duties. By E. G. Constantine, Assoc. M. Inst., C. E., M. I. Mech. E. Second edition. Published by D. Van Nostrand Company, New York. Price, $2.00.

The object of the author is to furnish information to various classes of readers, including parents and guardians who may have some idea of placing their sons in the way of becoming marine engineers; boys who aspire to become marine engineers; youths who are serving their apprenticeship either in land or marine engineering works, as well as those who are working as journeymen, but wish to go to sea; and young engineers who have made a start at sea. Obscure technicalities have been carefully avoided, and first principles have only been sufficiently touched on to indicate the course which, in the writer's opinion, is best calculated to secure the acquisition of that knowledge of the science of engineering and cognate branches which are the essential charactristics of the engineer.

Text Book on the Strength of Materials. By S. E. Slocum, assistant professor, University of Illinois, and E. L. Hancock, instructor at Purdue University. Cloth, 7 x 9½. 314 pages. Illustrated. Published by Ginn & Company, Boston. Price, $2.00.

The aim of the authors of this book has been to produce a text book of the best modern theory and practice and at the same time sufficiently elementary for the use of students of the junior grades in technical and engineering schools. The book has been divided into two parts, the first presenting the theoretical side of the subject and the second the experimenal side. The former is for use in the class room and the latter for a laboratory manual, and each important point is illustrated by a practical application. The exercises chosen for this purpose being for computation in Part I. and for observation in Part II. Some important features of this book are the definition of the moment of inertia as the shape factor in the mechanics of materials; graphical method of calculating centers of gravity and moments of inertia; application of the principle of least work; comparison of column formulas; accurate formulas for the torsion of shafts; simple methods of calculating the strength of curved pieces, and also a separate chapter on the modern use of reinforced concrete.

Locomotive Dictionary: An Illustrated Vocabulary of Terms Which Designate American Locomotives, Their Details of Construction, With Definitions of Typical British Locomotive Practice. First edition compiled for the American Railway Master Mechanics' Association, by Geo. L. Fowler; 623 pp. Published by *The Railroad Gazette*, New York. Price, $6.00.

In general arrangement the new Locomotive Dictionary follows the scheme of the last edition of the Car Builders' Dictionary, and consists of about 100 pages of definitions, followed by 523 pages of illustrations and drawings, both general and detailed, of modern American and British locomotives. Reference to figure numbers in the definitions and a carefully followed up system of numbered parts in both drawings and definitions makes the determination of the proper name or the location of any part rapid and accurate. In addition to this complete matter on both steam and electric locomotives, there are sections on locomotive appliances of all kinds and many modern machine tools for locomotive repair shops.

This volume will be found to be of great value for reference in railroad drafting rooms and motive power offices, and, even considered as a treatise illustrating modern locomotive design, it is by far the best work published in several years. In view of the fact that the first action of the Master Mechanics' Association, which has resulted in this work, was taken in June, 1905, the promptness with which it has been completed is to be most heartily commended.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

CRANDALL PACKINGS.—An attractive new catalog and price list is being issued by the Crandall Packing Company, Palmyra, N. Y. It contains illustrations showing the appearance and structure, accompanied by brief notes explaininig the special service for which each kind is adapted; of packings for all conditions of service on machines working steam, ammonia or hydraulic pressures. Sheet packings and gaskets of many different grades are included. This company carries a line of leather and rubber beltings as well as steam and water hose, which are also shown in the catalog.

ELECTRIC CRANES.—The Case Manufacturing Company, Columbus, Ohio, is issuing bulletin No. 22, in which are a large number of half-tone illustrations, accompanied by clear descriptive matter, showing the many improvements which have recently been made in the cranes manufactured by this company. Each detailed part of the crane is shown and considered separately. Special mention is made of the fact that cranes to be operated by alternating current can now be obtained which will give perfect satisfaction. This company manufactures cranes of all sizes and for all purposes.

GRAPHITE AS A LUBRICANT.—The tenth edition of "Graphite as a Lubricant" has just been printed, and is now being distributed by the Joseph Dixon Crucible Company. The subject of lubrication in general, and graphite lubrication in particular, is exhaustively treated. All the good features of the previous edition are retained, but the very latest information—both scientific and practical—that has to do with the subject is added, making it valuable to the student of theory and the man of practice. The publication is arranged and indexed so as to readily enable the reader to find the information he is most interested in.

FRANKLIN AIR COMPRESSORS.—The Chicago Pneumatic Tool Company, Fisher Building, Chicago, Ill., is issuing catalog No. 20, which is devoted exclusively to a detailed description of the Franklin air compressor. It is a book of 116 pages, containing illustrations with full detailed descriptive list of over 100 sizes and styles of this type of compressor. Several new designs, including the Corliss, motor-driven, gas engine driven and new large capacity patterns are shown. Considerable space is devoted to the subject of pumping by compressed air and the new Chicago Water Lift is described. A number of valuable tables and formulas are included.

SIGNAL TOWER OIL OUTFIT.—S. F. Bowser & Company, Fort Wayne, Ind., is issuing bulletin No. 57, which illustrates and describes the Bowser system of oil supply for use in signal towers. This arrangement places the pump in the tower and the tank in the ground. The apparatus complete is of the well-known design at present in use in the oil houses of many of the larger railway systems. In this case the tank is buried in the ground on the opposite side of the track from the tower, and the pump, which is of the self-measuring design, is placed at any convenient point in the tower.

THE DRAFT GEAR PROBLEM.—The Frost Railway Supply Company, Detroit, is issuing a pamphlet which contains reprints of two excellent papers recently presented on the draft gear problem. The first one is titled "Friction Draft Gear on Cars and Locomotives," and was presented at the May meeting of the Central Railway Club by Mr. W. O. Thompson, New York Central Lines. This is followed by Mr. A. Stucki's article on "Functions of a Good Draft Gear," which appeared in the *Railroad Gazette* of February 23, 1906. Comments by the Frost Company are given in red marginal notes, which call attention to the most vital features mentioned in the papers.

AIR HAMMER DRILLS AND AIR MOTOR HOISTS.—Bulletins on these two subjects are being issued by the Ingersoll-Rand Company, Pneumatic Tool Department, 11 Broadway, New York. The "Little Jap" hammer drill, with which one of the bulletins deals, has proved itself to be most valuable and is becoming almost indispensable for lighter work in rock excavations. The details of its construction and operation under different conditions are shown. The second pamphlet treats in a similar manner the "Imperial" motor hoists and stationary motors. It contains a complete description of the motor hoists, with tables of sizes and dimensions, and also the "Imperial" stationary motor, which fills the demand for a motor of small power for intermittent service.

Record of Recent Construction.—The Baldwin Locomotive Works, Philadelphia, is issuing the latest "Record of Recent Construction," which is numbered 59 and includes the usual illustrations and complete dimensions of a large number of freight and passenger locomotives of different types recently built at their works for American railroads.

Jeffrey Pulverizers.—The Jeffrey Manufacturing Company, Columbus, Ohio, is issuing catalog No. 31, which deals with crushing and pulverizing machinery. The catalog is very completely illustrated and shows several different designs of crushers and pulverizers manufactured. Each important detail, feature or part is illustrated and described separately, and machines of a number of different types and sizes are shown, tables being included for exact dimensions. These pulverizers are intended for use with coal, coke, ores, lime-stone, brick, bone, etc.

Consolidation Type Freight Locomotive.—A pamphlet just published by the American Locomotive Company illustrates and describes consolidation locomotives weighing more than 175,000 lbs. It is a sequel to the pamphlet issued in October presenting designs of this type weighing less than 175,000 lbs. In the pamphlet 28 consolidation locomotives built for various railroads, and ranging in weight from 175,000 lbs. to 250,000 lbs., are illustrated, and the principal dimensions of each design are given. This is the fourth of the series of pamphlets which is being issued by the American Locomotive Company to include all the standard types of locomotives. The series now covers the Atlantic, Pacific and consolidation types. Copies of these pamphlets may be had upon request.

Steam Engines and Electric Hoists.—The Allis-Chalmers Company, Milwaukee, Wis., is issuing bulletins Nos. 1506 and 1510, which are arranged to be bound in their loose-leaf binder. The former of these is on electric hoists, which are built complete by this company in single drums from 15 to 75 h.p. and in double drums from 30 to 150 h.p. The bulletin gives a complete description of all the different features of the hoists and contains tables showing dimensions, speeds, capacities, etc. Bulletin No. 1510 illustrates and describes the direct connected Reynolds Corliss engines of the heavy duty pattern. These engines are furnished in both simple and compound, horizontal, vertical or combined horizontal and vertical. One page is devoted to a list of the information required by the company in making estimates of sizes and prices.

Electric Supplies for Railways.—The General Electric Company is issuing a 233-page cloth bound catalog, which, it is stated, has been issued for the purpose of placing in the hands of its customers information which will enable them to readily select repair parts for the maintenance of equipment and lines, and for such other supplies as are best suited to the various requirements in the construction and operation of complete electric railway systems. The various classes of material are arranged to facilitate the selection of repair parts most often required, and each section includes descriptive matter sufficient for the customer to readily determine the exact material necessary for his particular needs. The catalog is very complete, and includes practically all apparatus used on electric railways. The same company is also issuing bulletins Nos. 4,465 and 4,467. The former on trolley frogs, their proper selection and location for different service, and the latter on the emergency straight air brake system.

NOTES.

Farlow Draft Gear Company.—About December 1 the Chicago office of this company will be moved from the present quarters in the Monadnock Building to 1713 Fisher Building.

Grip Nut Company.—This company is now represented in New York by Mr. T. F. DeGarmo, whose office is at 500 Fifth Avenue. The main office of the company is at 152 Lake Street, Chicago, Ill.

Crandall Packing Co.—Owing to increased business, which requires larger space, the Cleveland office of this company has been moved from 9 South Water Street to 805 Superior Street, N. W.

Chicago Pneumatic Tool Company.—Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, sailed for Europe on November 6th for a five weeks' trip in the interest of the company's business, during which time he will visit the important trades generally in England, Scotland, France and Germany.

The Dayton Pneumatic Tool Company.—This company is sending souvenir telescopic lead pencils to its friends.

Fairbanks, Morse & Co.—Mr. Albert A. Taylor, who for the past eight years has been a traveling representative for Fairbanks, Morse & Company, has been appointed manager of the railroad department of that company, with headquarters in Chicago. He supercedes Mr. W. H. Garrett.

Crocker-Wheeler Company.—This company is now installing a 300-k.w. alternating current generator in the Kingsland repair shops of the Delaware, Lackawanna & Western Railroad. Two similar machines have been working for a little over a year with entire success. This third machine has been installed to furnish the increased demand for power.

Advancing Prices of Electrical Apparatus.—It is announced that because prices in the electrical trade continue to show a distinct upward tendency in sympathy with the well-maintained advance which has taken place in the prices of all raw materials, orders for future delivery can now in many instances only be placed at a considerable advance over present market quotations. The General Electric Company, in common with many other large manufacturing concerns, is announcing a general advance in prices of electrical apparatus and supplies, which action will not unlikely be followed by further advances if present market conditions continue.

Commonwealth Steel Company.—The controlling interest in this company has been purchased by Mr. Clarence H. Howard from the American Steel Foundries, which now holds no interest whatever in the company. The plant of the company, which has a capacity of about 3,000 tons per month, is located at Granite City, Ill. The newly elected officers are as follows: Clarence H. Howard, president; Thomas K. Niedringhaus, vice-president; Harry M. Pflager, vice-president; George K. Hoblitzelle, vice-president and treasurer; Frank L. Morey, secretary and auditor; George E. Howard, vice-president and sales agent; Arthur T. Morey, assistant to the president and general attorney; W. E. Hoblitzelle has been appointed general manager; Charles T. Westlake, general mechanical engineer; C. F. Frede, mechanical engineer, and R. A. Bull, general superintendent.

The Arnold Company.—The locomotive shop of the Grand Trunk Railway at Battle Creek includes the machine and erecting, boiler and tank shops under one roof, the building being 170 by 817 ft., and containing 25 erecting pits, 9 boiler stalls and 9 tank stalls. The foundation work on this building is started. Other buildings of the locomotive department will follow shortly, as the intention is to have this department ready for operation before the end of 1907. Bids have been received for the boiler and forge shop of the Big Four at Indianapolis, and the contract will be let shortly. Work on the power house, tank shop and the storehouse is being pushed rapidly. The Kansas City Southern Railway shops at Pittsburg, Kan., roundhouse and power house, coaling pocket, cinder pits and sand house are nearing completion. The complete improvements in addition will include a new 16-pit machine and erecting shop, 30-ton yard crane, transfer table and reinforced concrete oil house.

New Steel Car Plant.—The Standard Steel Car Company, Frick Building, Pittsburgh, with main works at Butler, Pa., recently bought 380 acres of land at Hammond, Ind., on which it will erect a very large plant for the manufacture of steel cars. The plant originally will have five main buildings, contract for which has been placed with the McClintic-Marshall Construction Company, Pittsburgh, and which will require about 4,000 tons of steel. The steel car shop will be contained in a steel building about 1,600 ft. long and 300 ft. wide, while the wooden car shop will also be contained in a steel building 1,600 ft. long and about 200 ft. wide. The truck shop, paint shop and car house will each be contained in separate steel buildings, ranging in size from 500 to 800 ft. long. The new plant will have a capacity for turning out about 60 steel and composite cars per day, the latter being wooden cars with steel underframe. This new plant is expected to be ready for operation about August 1, 1907. The works of this company at Butler, Pa., have been greatly enlarged in the past two or three years, and are now turning out from 90 to 100 steel cars per day, so that when the new plant at Hammond is finished and in operation the Standard Steel Car Company will have a capacity for making from 150 to 160 steel cars per day.